An Investigation into the Extent and Derivation of Mathematics Anxiety among Mature Students in Ireland

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Doctor of Philosophy

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Abstract

An increasing number of students entering higher education undergraduate programmes in Ireland are required to take modules in mathematics, referred to as ‘service mathematics’ where mathematics is a component of study, but not the main discipline of study. For some students, their engagement with service mathematics can be accompanied by apprehension and fear, particularly if previous experiences of mathematics have been negative. This can be especially true for mature students, who may not have had exposure to formal mathematics for a number of years and may feel at a disadvantage compared with those ‘traditional’ students who entered higher education after completing the Leaving Certificate examination.

The term ‘mathematics anxiety’ is used by numerous researchers to conceptualise the apprehension and fear among students in relation to their dealings with mathematics. Much research into mathematics anxiety has focused on issues pertinent to second-level and ‘traditional’ higher education students. To this end, the researcher has identified the need to examine the extent to which mathematics anxiety exists among mature students learning service mathematics. As a social construct, mathematics anxiety lends itself to exploration using a mixed methods approach. To this end, the research design comprised two-phases; first, a survey including the Mathematics Anxiety Scale–UK (MAS-UK) was completed by 107 undergraduate mature students in Irish Higher Education Institutions. Second, adapted life story interviews were conducted with twenty of these mature students to facilitate an insight into their individual experiences with mathematics, leading to the identification of specific incidents of engagement with mathematics that may have contributed to their levels of mathematics anxiety. The findings show that mathematics anxiety exists at varying levels among these mature students, and that there are significant incidents that contribute to the level of anxiety experienced which stem from a combination of factors from their past experiences with mathematics in the school and home environments.
Declaration of Originality

This thesis is presented in fulfilment of the requirements for the degree of Doctor of Philosophy. It is entirely my own work and has not been submitted to any other University or higher education institution, or for any other academic award in this University. Where use has been made of the work of other people it has been fully acknowledged and fully referenced.

Name: Maria D. Ryan

Signature: ________________________
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- My children – James and Kate – who have grown up as this Ph.D. has evolved, and I thank them for their love and patience.
<table>
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<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>DES</td>
<td>Department of Education and Science</td>
</tr>
<tr>
<td>DEIS</td>
<td>Delivering Equality of Opportunity in Schools</td>
</tr>
<tr>
<td>ERC</td>
<td>Educational Research Centre</td>
</tr>
<tr>
<td>ESRI</td>
<td>Economic and Social Research Institute</td>
</tr>
<tr>
<td>HE</td>
<td>Higher Education</td>
</tr>
<tr>
<td>HEI</td>
<td>Higher Education Institution</td>
</tr>
<tr>
<td>IoT</td>
<td>Institute of Technology</td>
</tr>
<tr>
<td>MA</td>
<td>Mathematics Anxiety</td>
</tr>
<tr>
<td>MAS-UK</td>
<td>Mathematics Anxiety Scale – U.K.</td>
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<tr>
<td>NAP</td>
<td>National Assessment Programme</td>
</tr>
<tr>
<td>NESC</td>
<td>National Economic and Social Council</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
</tr>
<tr>
<td>PIAAC</td>
<td>Programme for International Assessment of Adult Competencies</td>
</tr>
<tr>
<td>PISA</td>
<td>Programme of International Student Assessment</td>
</tr>
<tr>
<td>TIMSS</td>
<td>Trends in International Mathematics and Science Study</td>
</tr>
<tr>
<td>Uni</td>
<td>University</td>
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# Definitions

<table>
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<tr>
<th>Term</th>
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<tr>
<td>Higher Education</td>
<td>Tertiary education provided by Universities, Institutes of Technology and Colleges of Education (DES, 2019)</td>
</tr>
<tr>
<td>Junior Certificate</td>
<td>State examination at the end of the Junior Cycle (SEC, 2019)</td>
</tr>
<tr>
<td>Junior Cycle</td>
<td>First three years of secondary school for ages 12 to 15 (SEC, 2019)</td>
</tr>
<tr>
<td>Leaving Certificate</td>
<td>State examination and terminal examination at the end of the Secondary school (SEC, 2019)</td>
</tr>
<tr>
<td>Mathematics Anxiety</td>
<td>Feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations&quot; (Richardson &amp; Suinn, 1972: p. 551)</td>
</tr>
<tr>
<td>Mature Student</td>
<td>In the Irish context, a mature student is defined as being 23 years or more on January 1st in the year of entry or re-entry to an approved course (Citizens Information, 2013)</td>
</tr>
<tr>
<td>Primary School</td>
<td>Eight-year school cycle commencing at age 4 approximately, with completion at age 12 (DES, 2019)</td>
</tr>
<tr>
<td>Secondary (or Second Level) School</td>
<td>Comprises a three-year Junior Cycle (lower secondary) for ages 12 to 15, followed by a two or three year Senior Cycle (upper secondary), depending on whether the optional Transition Year (TY) is taken; ages 16 to 17/18. (DES, 2019).</td>
</tr>
<tr>
<td>Senior Cycle</td>
<td>Two-year period at the end of secondary school culminating in the Leaving Certificate Examination (SEC, 2019)</td>
</tr>
<tr>
<td>Service Mathematics</td>
<td>Mathematics is a component of study, comprising an essential component of the degree but not the main discipline of study (Macbean, 2004; Gill &amp; O’Donoghue, 2008)</td>
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Chapter 1 Introduction
1.0 Introduction

The experience of teaching service mathematics at undergraduate level over a period of almost two decades has exposed the researcher consistently to negative comments from mature students about their dislike of mathematics. Despite the fact that many of these experiences had happened years before, the impact on the student was still evident in the higher education context, with the students expressing anxiety from the start of the academic term at the prospect of engaging with their service mathematics coursework and examinations. The nature of these negative stories has changed little in twenty years, and the persistent anecdotal evidence prompted the researcher to investigate such stories further in an attempt to identify the causes of mature students’ negative feelings towards mathematics. In this regard, the researcher was conscious that the negativity had accompanied the mature students into higher education and would be present as they engage with service mathematics; thus, obtaining an insight into what causes mature students to be anxious about mathematics would ultimately help the researcher to improve her own practice in respect of catering to the needs of mature students with mathematics anxiety.

The many experiences shared by mature students over the years prompted the researcher’s interest in the extent of the problem of mathematics anxiety among mature students and the sources of this anxiety in respect of mathematics that has resulted in these students feeling the way they do about mathematics.

1.1 Context for Research

Among all subjects and disciplines of study, mathematics has the propensity to evoke strong negative emotions and varied responses when introduced as a topic for discussion, particularly when an individual is asked how they feel about mathematics (Boaler, 2016; DiMartino & Zan, 2011). Negative feelings towards mathematics can present themselves in many ways, from dislike or fear of mathematics to anxiety towards mathematics and avoidance of mathematics (Betz, 1978; Langpaap, 2005; Wilder, 2013; Zaslavsky, 1994). Mathematics anxiety is a prevalent, negative emotion that fosters dislike of and aversion towards mathematics (Baloglu & Kocak, 2006). The need to understand the nature of mathematics anxiety stems from its correlation with poor performance in mathematics and avoidance of mathematics (Ashcraft & Moore, 2009; Evans, 2000), and its impact on students at all levels of the education system (Dowker, Sarkar & Looi, 2016).
An increasing number of students entering higher education undergraduate programmes are required to take modules in mathematics and/or statistics (Lawson, Croft & Halpin, 2003). For some students, their approach to learning service mathematics can be accompanied by apprehension, particularly if previous experiences of mathematics have been negative (Coben, 2003). This can be particularly true in the case of mature students, who have been out of school for a number of years and may feel at a disadvantage compared with those ‘traditional students’ who entered higher education after completing the Leaving Certificate (Gill & O’Donoghue, 2006; Golding & O’Donoghue, 2005). For some mature students these negative feelings can be characterised as mathematics anxiety (Richardson & Suinn, 1972) which can lead to intimidation and negativity among students, affecting confidence and progress (Golding & O’Donoghue, 2005).

Mature students are also known as ‘non-traditional’ students (Wright, 1989) and, while the term is used synonymously with ‘adult learners,’ the latter term is a broader term which describes learners who have reached adulthood and have gained prior knowledge and expertise as a result of life and work experience, in addition to or instead of additional exposure to any formal education (Toynton, 2005). Mature students are defined as 23 years or older on the first of January in the year of enrolment to higher education in Ireland (HEA, 2014a). The age varies in different jurisdictions ranging, for example, from 21 years in the United Kingdom, to 23 years in Portugal, 24 years in the United States of America, and 25 years in Sweden, Australia, and New Zealand (OECD, 2018; Thomas & Quinn, 2007).

The White Paper on Adult Education (DES, 2000) proposed to increase the number of mature students participating in higher education in Ireland by offering incentives to return to education, such as assistance with fees and maintenance, tax relief, and support for persons with disabilities (Citizens Information, 2013); however, the prospect of having to learn ‘service mathematics’ where mathematics is a component of study, but not the main discipline of study (Gill & O’Donoghue, 2008) may act as a deterrent to participation by mature students in higher education programmes of study (Klinger, 2005). The profile of the mature student is non-homogeneous; the cohort encompasses diversity in the range of ages, family situations and responsibilities, career experiences, and previous encounters with education (Lynch, 1997; O’Donnell & Tobbell, 2007). An examination of the context of the mature student as the adult learner returning to
education and the issues faced will serve as a backdrop for the examination of the circumstances that may give rise to the presence of mathematics anxiety.

Mathematics anxious students often perceive themselves to be no good, incompetent or useless at mathematics and will avoid seeking help so that they will not have to admit their true feelings towards mathematics, and thereby risking looking stupid at mathematics (Tobias, 1993). In turn, the frustration at not being able to do mathematics gives rise to mathematics anxiety (Tobias, 1993). Initial approaches to problem-solving can result in the mathematics anxious student giving up at an early stage of the process, especially if they believe the problem is difficult; in this situation the mathematics anxious student believes that they cannot solve such a problem, and that attempts at solving the problem will be futile (Tobias, 1993). In this regard, effective supports and guidance are essential for the mathematics anxious student, both before and during engagement with mathematics (Faulkner, Fitzmaurice & Hannigan, 2016; Ryan & Fitzmaurice, 2017).

In the case of mature students, their life experience and motivation for enrolling in an undergraduate programme positively enhance their disposition towards their studies, and since many mature students have commitments outside of the higher education environment, they are keen to maximise the time and energy they give to their education (Safford-Ramus, 2008). If a mature student has reservations about their ability in mathematics they will proactively talk to their lecturers and will seek support with mathematics, including availing of preparatory or induction programmes, as well as mathematics support (Pritchard & Roberts, 2006). However, a higher level of anxiety towards mathematics may also cause the student to resort to coping mechanisms, including avoidance tactics, and a willingness to get through the coursework and examinations (Ashcraft & Krause, 2007; Betz, 1978; Turner, Midgley, Meyer, Gheen, Anderman, Kang & Patrick, 2002).

Mature students are forthcoming in talking about their – particularly bad – experiences with mathematics, and these tend to impact on how they talk about mathematics (Finlayson, 2014; Zaslavsky, 1994). Telling their stories can be therapeutic for the student and can facilitate the understanding of their issues with mathematics by the student themselves; these stories can also help the lecturer gain an insight into the extent of the problem the student has with mathematics. The discussion around mathematics anxiety in the literature has included consideration of the antecedents of mathematics anxiety and
influences on the student of mathematics; collectively, these include the influence of significant persons (teachers, parents, peers), the effect of home and school environments, the connection with achievement in – and avoidance of – mathematics, gender and mathematics, the perception of mathematics nationally, and other social factors. Thus, an understanding of the situations and experiences that have led to the level of anxiety the student exhibits warrants investigation in order that the relevant supports and resources are put in place to meet the needs of the mathematics anxious student and minimise the negative effects of their anxiety.

1.2 Researcher Positioning

The researcher’s awareness of the difficulty encountered by some mature students in respect of mathematics has provided the impetus to find out about such experiences in relative detail than that provided anecdotally by those mature students that have communicated their feelings about mathematics to the researcher. This level of interest helps to orient the researcher’s approach to the research project, while being open to the possible variety of outcomes the research design may accrue (Caughey, 2006; Mertens, 2015).

The choice of research participant and their decision whether or not to participate in the research process is influenced by the researcher’s positioning (Kerstetter, 2012; Parker-Jenkins, 2016). As part of the research process the need to hear the stories of mature students meant that the researcher would meet the students in a situation where there would be awareness of power dynamics on both sides (Foucault, 1980). In this regard, before sending requests to participate in the survey, as well as in advance of the interviews being scheduled, the researcher was up-front in communicating to mature students her positioning – i.e. a practitioner in higher education teaching service mathematics undertaking Ph.D. research – in order that students could decide from the outset of the research project if they wanted to engage with the process. Also, at the start of each interview the researcher emphasised the intention behind the research, i.e. to hear the students’ stories about their experiences with mathematics. However, while it is likely that mature students – being older than traditional students – would have come to the interview situation with a mature outlook and demeanour, it is also possible that due to the perceived power dynamic of the interview situation, the student may have withheld some information about their previous engagement with lecturers or teachers. The
researcher is also conscious of the fact that due to her positioning as a practitioner within higher education, this may have been a deterrent to some potential interviewees.

The progression of the research journey and the accompanying learning process has been paralleled by engagement in professional development opportunities, as well as adjustments to the researcher’s practice, including trying out new teaching methods and assessment methods, resulting in more positive feedback from students. In this regard, the successful completion of ten modules during the first two years of the structured Ph.D., the presentation of research papers at various conferences, as well as attendance at relevant conferences, seminars and workshops (Appendix A), have been conducive to gaining new insights into best practice in the teaching and learning of service mathematics in HE.

1.3 Significance of the Research

While the research into mathematics anxiety at all levels of the education spectrum is extensive and well-established, the study of mathematics anxiety with an exclusive focus on mature students is sparse with a small literature base, both internationally and in the Irish context. In this regard this study provides unique insights into the extent of mathematics anxiety among undergraduate mature students who are studying service mathematics as part of a broader discipline of study, as well as eliciting details of the experiences that have resulted in the levels of mathematics anxiety they experience. The findings of the study will be useful to policy makers, and practitioners at all levels of the education spectrum, both in Ireland and internationally.

The exclusive focus on mature students in this study has provided an insight into the demographics of current mature learners in Ireland, which shows notable changes since the last comprehensive study looking at the profile of mature students in Ireland over two decades ago (Lynch, 1997).

The advantages of using a mixed methods research design have come to the fore in this study, with the qualitative data enhancing the quantitative data, leading to a richer insight into the research topic.

1.4 Research Aim and Questions

The purpose of this study is to better understand the extent of mathematics anxiety among mature students in Ireland, and to identify what are the significant incidents in their lives
that lead to the – particularly negative – feelings they have about mathematics. In this regard, it is envisaged that the findings will inform participants involved in the teaching and learning of mathematics, at primary, secondary and tertiary level education in Ireland, and further afield.

The aim of this research is:

To investigate the existence and derivation of mathematics anxiety among mature students studying service mathematics in Ireland.

Two key research questions have been derived to assist in achieving the research aim.

1. To what extent does mathematics anxiety exist among mature students studying service mathematics in Ireland?

2. To what extent do specific incidents in a mature student's mathematics life story give rise to the level of mathematics anxiety that the student experiences or identifies with?

The nature of these research questions necessitates different approaches to data collection in order to address each question; question 1 is addressed using a survey, and question 2 is addressed using a mixed methods approach, namely survey data combined with life story interview data. These methods are elaborated upon in the following section.

1.5 Research Methodology

The study of mathematics anxiety has revealed a multidimensional construct (Alexander & Cobb, 1984; Ganley & McGraw, 2016; Rounds & Hendel, 1980), including the manifestation of physiological, affective and cognitive aspects of anxiety (Ganley & McGraw, 2016; Hart, 1989; Ma, 1999; Wigfield & Meece, 1988), as well as comprising different components pertaining to engagement with mathematics, such as mathematics evaluation anxiety, mathematics learning anxiety (Ganley & McGraw, 2016; Hopko, Mahadevan, Bare & Hunt, 2003; Plake & Parker, 1982), and mathematics observation anxiety (Hunt, Clark-Carter & Sheffield, 2011). It is necessary to pinpoint and understand the features of mathematics anxiety, and in this regard, the use of the right research method(s) is essential (Wilder, 2013). Since the 1970s the identification of mathematics anxiety has typically been conducted largely using Likert-type tests which purport to measure the level of the research participant’s mathematics anxiety (Hunt, Clark-Carter & Sheffield, 2011); more recently various qualitative approaches including interviews with individual students and the facilitation of autobiographical accounts have aimed to
tap into students’ personal experiences with mathematics anxiety (Drake, 2006; Thumpston & Coben, 1994). To a lesser extent some mixed methods approaches have used a combination of the above methods to gain a richer insight into the construct (Wilson, 2017).

This study has adhered to a sequential pragmatic mixed methods approach (Mertens, 2015), which has been dictated by the researcher’s ontological and epistemological positioning as a practitioner teaching service mathematics in higher education in Ireland. Having compiled and piloted the data collection instruments and associated documentation, the researcher sought ethical approval, which subject to minor amendments, was granted in February 2015. The data collection process involved a quantitative phase (phase one), followed by a qualitative phase (phase two). The purpose of phase one – the survey – was to ascertain the level of mathematics anxiety among the mature student respondents. Mature students from four higher education institutions in Ireland were invited to participate in the survey and 107 completed questionnaires were submitted. The questionnaire asked mature students for some personal details, as well as to complete the Mathematics Anxiety Scale – UK (MAS-UK) test (Hunt et al., 2011); participants were also given the option to opt in to participate in phase two of the study. The survey data was collated and analysed, and the results contributed to addressing research question 1.

Phase two involved conducting life story interviews with the intention of eliciting insights into mature students’ individual experiences with mathematics. Twenty mature students met the researcher for interview, which was facilitated by McAdams’s (1993) Life Story Framework, thereby enabling insights into the mature students’ experiences with mathematics throughout their lives. The questionnaire data for the twenty mature student interviewees were analysed, and their life story data were also analysed; the two sets of analysed data were then integrated to present the set of results to address research question 2.

1.6 Theoretical Perspective

The research topic builds upon the fields of research into the themes of mathematics anxiety and the mature student, as separate and combined research foci. The researcher identifies with Duke and Martin's description of the research process as “a slow accumulation of knowledge over time [through reading] across many different studies on
[the] particular question or topic” (Duke & Martin, 2011: p. 21). To this end, elements of mathematics education, social psychology and adult-learning are inextricably linked within this study. Informed by the philosophy of pragmatism, the approach here requires that the researcher – guided by the research questions – seeks to understand the negativity that exists among mature students towards mathematics and will use whatever methods deemed appropriate to address the research aim. In this regard, the study of the research topic is facilitated using Cemen’s (1987) Model of a Mathematics Anxiety Reaction, which allows the analysis of mathematics anxiety by taking into account the influence of past experiences on the mature student’s disposition towards mathematics, as well as current situations involving mathematics that give rise to the anxiety reaction.

1.7 Roadmap of the Thesis

Chapter 2 presents the literature review for the study, beginning with a review of definitions of mathematics anxiety and related terms. The review of the literature on mathematics anxiety is framed by Cemen’s (1987) Model of a Mathematics Anxiety Reaction, and comprises three sub-sections: environmental antecedents, dispositional antecedents, and situational antecedents. This is followed by a review of literature on the mature student and is framed by Lynch’s (1997) research profiling the Irish mature student.

Chapter 3 presents the research design for the study. As a social construct, mathematics anxiety warrants investigation using a mixed methods approach; thus, the study adopted a two-phase research design. Phase one consisted of a survey, whereby a questionnaire was distributed to mature students at four HEI’s around Ireland – two universities (hereafter Unis) and two institutes of technology (hereafter IoTs). The primary purpose of phase one – the survey – was to quantify the level of mathematics anxiety among the mature students who participated. The primary purpose of phase two was to build on the findings of phase one and, by hearing from mature students themselves, find out about their life experiences with mathematics, and how these experiences might have influenced their engagement with the subject, and consequently impacted on the level of anxiety they feel in respect of mathematics.

Chapter 4 presents the data analysis for the survey, comprising quantitative analysis for the sample of 107 mature students. The intention is to analyse this data set thereby preparing the results to address research question 1; in this regard the approach to analysis
will facilitate an insight into the demographics of this cohort, as well as investigate their levels of mathematics anxiety as presented through the MAS-UK test and its factors: Mathematics Evaluation Anxiety, Environmental/Social Mathematics Anxiety, and Mathematics Observation Anxiety. In this regard, the analysis relies on descriptive statistics and relevant tests to elucidate the significant results within the data set.

Chapter 5 presents the data analysis for a subset of the data set in chapter 4, thereby presenting the analysis of the questionnaires for the 20 interview participants. The chapter mimics the approach taken in chapter 4 to reveal significant statistics; however, much attention is given to the MAS-UK data and its three factors. This chapter combined with the analysis of chapter 6 allow for the integration of results for the twenty mature students with the intention of addressing research question 2. These results are presented in chapter 7.

Chapter 6 presents the analysis of the qualitative data of the twenty mature students who opted in to participate in the life story interview. The interview – and consequently the chapter – is framed by the adapted life story framework, resulting in ten sections, one for each interview question, thereby setting *a priori* themes for the analysis. Subsequently, additional sub-themes emerged under each theme.

Chapter 7 presents the findings of the data analysis as they address the research questions; the first research question is addressed through the results of the quantitative data (from chapter 4), and the second research question is addressed through the integration of the quantitative and qualitative results for the twenty mature students (from chapters 5 and 6).

Chapter 8 presents the discussion and is structured using the format of the Model of a Mathematics Anxiety Reaction (Cemen, 1987). The findings are discussed under the main headings of environmental antecedents, dispositional antecedents, and situational antecedents, and their respective sub-headings.

Chapter 9 presents the conclusion of the thesis, including a summary of the thesis, implications of the research, recommendations arising from the research, strengths and limitations of the research, as well as suggestions for future research.
Chapter 2 Literature Review
2.0 Introduction

The purpose of this chapter is to explore the literature in respect of mathematics anxiety and mature students. In this regard, the presentation of the chapter hinges on two central themes: mathematics anxiety and mature students. First, characterisations of mathematics anxiety are presented including definitions, and related terminology, as well as sources of mathematics anxiety as framed by the Model of Mathematics Anxiety (Cemen, 1987). In this regard, themes exploring the detection of mathematics anxiety are presented, as well as an insight into ways of addressing mathematics anxiety. Second, a profile of the Irish mature student is presented. Finally, the chapter concludes by looking at how mathematics is perceived in society nowadays.

2.1 Characterisation of Mathematics Anxiety

Negative feelings towards mathematics take many forms, ranging from a dislike or fear of mathematics to avoidance of mathematics (Betz, 1978; Langpaap, 2005; Wilder, 2013; Zaslavsky, 1994). Early attempts to characterise negative feelings towards mathematics can be traced to the mid-20th century, when Gough (1954) coined the "self-definitive" term *mathemaphobia* (Gough, 1954: p. 290) to describe the cause of many failures in mathematics classes. Dreger and Aiken (1957) presented the expression *number anxiety* to describe “a syndrome of emotional reactions to arithmetic and mathematics” (Dreger & Aiken, 1954: p. 344).

Baloglu (1999) asserts the difficulty in defining mathematics anxiety and contends that it can be conceptualised as “a situation-specific anxiety that manifests itself in mathematics-related environments” (Baloglu, 1999: p.16). A number of definitions for mathematics anxiety have been presented since the 1970s; Richardson and Suinn (1972) have been credited with an authoritative – and commonly used – definition (Hunt, Clark-Carter & Sheffield. 2011; Wilder, 2013) of mathematics anxiety, namely "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (Richardson & Suinn, 1972: p. 551); Fennema and Sherman (1976) describe mathematics anxiety with reference to the physiological effect: “feelings of anxiety, dread, nervousness, and associated bodily symptoms related to doing mathematics” (Fennema and Sherman, 1976: p. 326), as do Tobias and Weissbrod (1980): “panic, helplessness, paralysis, and mental disorganisation that arises among some people when they are required to solve a mathematical problem”,
Hembree (1990) describes mathematics anxiety as distinct from test anxiety and focusing on academic situations comprising “a general fear of contact with mathematics, including classes, homework, and tests” (Hembree, 1990: p. 45); Byrd (1982) provides a broad definition: “any situation in which an individual experiences anxiety when confronted with mathematics in any way” (Byrd, 1992: p. 38); Maloney and Beilock (2012) depict mathematics anxiety as “an adverse emotional reaction to math or the prospect of doing math” (Maloney & Beilock, 2012: p. 404); Kogelman and Warren’s (1979) description makes reference to the origin of mathematics anxiety, namely an “intense emotional reaction to mathematics based on past experiences” (Kogelman & Warren, 1979: pps. 9-10), while Ashcraft describes mathematics anxiety as having “both immediate cognitive and long-term educational implications” (Ashcraft, 2002: p. 184).

Variations in terminology surrounding anxiety towards mathematics include Lazarus’ (1974) mathophobia presented as “an irrational and impeditive dread of mathematics;” Buxton’s (1991) math panic, described as an “extreme form of mathematics anxiety;” and Fiore’s (1999) math abuse, describing the onset of mathematics anxiety as a result of “any negative experience related to an individual’s doing mathematics” (Fiore, 1999: p. 403), in particular where the student has been subjected to verbal or physical abuse. More recently, the extreme impact of a distressing mathematics experience on a student has been identified as mathematics trauma, which “stems from an event, a series of events, or a set of circumstances experienced by an individual as harmful or threatening such that there are lasting adverse effects on the individual’s functioning and well-being in the perceived presence of mathematics” (Allen, 2016). The use of such strong, emotive words – phobia, panic, abuse and trauma – in respect of mathematics is unique to this subject and demonstrates the impact the subject can have on individuals who feel powerless to escape such circumstances (Allen, 2016).

**2.1.1 Mathematics Anxiety and Test Anxiety**

The many definitions of mathematics anxiety – and indeed the absence of one universal definition (Zan, Brown, Evans, & Hannula, 2006) – indicate the complexity of the construct (Baloglu, 1999; Bessant, 1995; Wilder, 2013), as well as the interest in the construct from many perspectives, including psychology and education (Buckley, Reid, Goos, Lipp & Thomson, 2016; Reyes, 1984), as well as neuroscience (Maloney & Beilock, 2012; Young, Wu & Menon, 2012), with the discipline of psychology being
responsible for the development of much of the theory on mathematics anxiety (Allen, 2016; Henschel & Roick, 2018). Early research into mathematics anxiety evolved from the study of test anxiety (Sarason, 1961) in the discipline of psychology (Reyes, 1984; Zan et al., 2006). While mathematics anxiety is conceptually related to test anxiety (Zeidner & Matthews, 2011), mathematics anxiety is a unique (Dreger & Aiken, 1957; Hembree, 1990; Suarez-Pellicioni, Nunez-Pena, & Colome, 2016) and multidimensional (Bessant, 1995) construct. It is described as a distinctive subtype of anxiety (Cargnelutti, Tomasetto & Chiaro Passolunghi, 2017; Hembree, 1990), and can be felt in specific situations, distinct from those that may give rise to general anxiety and test anxiety (Hembree, 1990; Young et al., 2012). Two prominent deliberations from the study of test anxiety that resonate with the study of mathematics anxiety include the contention that there exists a negative correlation between test anxiety and performance, and that test anxiety develops as a consequence of repeated poor performance (Reyes, 1984; Zan et al., 2006).

2.1.2 Mathematics Anxiety as Trait, State, and Process Anxiety

Spielberger and colleagues (1970, cited in Roos et al., 2015) distinguish between trait and state anxieties; trait anxiety is habitual (Roos et al., 2015: p. 245), akin to an attitude (Buckley et al., 2016), and is based on the student’s recollection of past events, which may result in subjective accounts of the anxiety trigger (Roos et al., 2015). By contrast, state – or ‘on-task’ (Buckley et al., 2016) – anxiety is momentary (Roos et al., 2015: p. 245) and concerns transitory anxiety in a real-life situation (Spielberger et al., 1970, cited in Roos et al., 2015). The measurement of state emotions more realistically estimates the actual momentary emotion, whereas the measurement of trait emotions is more reflective of the students’ beliefs about their experiences (Cemen, 1987; Robinson & Clore, 2002). For investigations into mathematics anxiety, much focus in the literature has been on the measurement of trait mathematics anxiety (Buckley et al., 2016; Roos, Bieg, Goetz, Frenzel, Taxer & Zeidner, 2015), which is more useful in gauging students’ beliefs about their emotions, typically when reflecting on past events or events that have influenced their emotions (Roos et al., 2015); while measurement of state mathematics anxiety is more challenging for researchers in that the approach to investigate state mathematics anxiety would necessitate observation of the student taking a mathematics test or being evaluated in a mathematics situation (Buckley et al., 2016; Chinn, 2017; Roos et al., 2015).
Subsequently, Spielberg presented a third classification of anxiety – anxiety as process – which comprises the “sequence of cognitive, affective, and behavioural responses that occur as a reaction to some form of stress” (Spielberger, 1972, cited in Cemen, 1987: p. 3). Spielberger’s model contends that if the presence of a stressor in the individual’s environment is perceived as a threat, it elicits an anxiety reaction, which is followed by the individual deciding how to deal with the anxiety and the stressor, and is followed by a coping strategy (Spielberger, 1972, cited in Cemen, 1987: p.3). In the context of test anxiety, Cassady (2010) refers to this process as an “additive model of test anxiety” (p.9) whereby the individual’s trait anxiety when confronted with a threatening evaluative situation gives rise to the individual’s state anxiety and results in a negative emotional response. The anxiety-as-process model influenced the formulation of Cemen’s Model of a Mathematics Anxiety Reaction which represents a method for the study of mathematics anxiety (Cemen, 1987).

2.2 Sources of Mathematics Anxiety

The need to address the challenges posed by mathematics anxiety gives rise to the need to extensively understand the factors that give rise to students becoming mathematics anxious, and at which stages of their education anxiety towards mathematics becomes apparent (Maloney & Beilock, 2012). Aiken (1976) identifies contributing factors that can result in a change in attitude towards mathematics; the student-teacher interaction, syllabus, teaching methods, teaching resources, support of parents and peers, and how these changes in attitudes are measured. Ashcraft and Moore (2009) contend that students who are susceptible to mathematics anxiety include those with low skills levels, a lack of motivation, and inadequate working memory. Further, a learning disability such as dyslexia or dyscalculia (NCSE, 2018) can also inhibit the student’s effective engagement with mathematics and lead to mathematics anxiety (Ansari, 2013; Mazzocco, 2007). Indeed, the demand on mathematical skills and knowledge in any situation can give rise to mathematics anxiety (Cavanagh & Sparrow, 2011). Thus, the possible sources of mathematics anxiety are complex and varied (Jameson, 2010; Vukovic, Roberts & Wright, 2013b), and can be down to many factors, including the student themselves, the influence of other people – teachers, parents, peers – as well as cultural, societal and environmental influences (Dreger & Aiken, 1961; Vukovic et al., 2013b; Wigfield & Meece, 1988).
An approach to investigating the variables that have an effect on mathematics anxiety was presented by Cemen (1987) – Model of a Mathematics Anxiety Reaction (Figure 2.1) – using the classifications of environmental, dispositional, and situational antecedents or factors (Baloglu & Kocak, 2006; Belbase, 2013; Cemen, 1987), the combination of which gives rise to mathematics anxiety (Buckley & Reid, 2013; Cemen, 1987).

![Figure 2.1 Cemen’s Model of a Mathematics Anxiety Reaction](sourced Cemen, 1987: p. 18)

The presence of a trigger or stressor combined with the individual’s perception of the threat to their self-esteem contributes to the extent of the mathematics anxiety reaction; this gives rise to cognitive reappraisal on the part of the individual who must consider a way of coping depending on their propensity to deal with the situation (Cemen, 1987). In order to address the research aim and examine the situations that give rise to mathematics anxiety, the following sections explore the three classifications of antecedents – environmental, dispositional, and situational – in more detail.
2.2.1 Environmental Antecedents

Environmental antecedents are external factors arising from the past, that have affected the individual and impact upon dispositional factors; these include parental attitudes, parental attitudes, and where parental encouragement is lacking; the influence of teachers, and peers; and various negative experiences of mathematics as a subject (Baloglu & Kocak, 2006; Belbase, 2013; Buckley & Reid, 2013; Cemen, 1987; Goodall Johnston-Wilder & Russell, 2017). Negative perceptions of the student’s ability in mathematics may be held by others, including teachers and parents (Hannula, Evans, Philippou & Zan, 2004; Hoffmann, 2010; Rounds & Hendel, 1980), which can be detrimental to the student’s self-esteem and self-concept in mathematics (Cemen, 1987; Chinn, 2017).

The emphasis on the teacher’s demand for correctness (Chinn, 2017; Turner, Midgley, Meyer, Gheen, Anderman, Kang & Patrick, 2002), as well as a lack of cognitive and motivational support (Ashcraft & Krause, 2007), results in the likely outcome that students – having to demonstrate their incompetence – would feel vulnerable in a public situation such as the classroom. This in turn may lead to reluctance by the student to request help subsequently from the teacher (Ashcraft & Krause, 2007; Fiore, 1999). The teacher as experienced in this way can contribute to a negative experience of mathematics by the student, resulting in an adverse relationship with mathematics, which impacts negatively on students’ subsequent engagement with mathematics, especially with respect to voluntarily choosing mathematics courses at an advanced level, for example in high school (senior cycle) or beyond (Ashcraft & Krause, 2007). An unwillingness or inability to engage with mathematics or the inability to catch up with missed mathematics content as a result of absenteeism leads to the student falling behind and becoming further disengaged with mathematics (Cemen, 1987; Chinn, 2017). Further, the impact of punishment of a student for failure or poor performance in mathematics – either by a teacher or a parent – contributes to the student’s dislike of and reluctance to engage with mathematics (Dutton, 1954; Miller & Mitchell, 1994; Vukovic et al., 2013b); these experiences are anxiety-inducing (Buckley & Reid, 2013; Cemen, 1987), and can hamper progress (Boaler, 2016).

2.2.2 Dispositional Antecedents

Dispositional antecedents constitute the student’s own personality-related issues, including a negative attitude towards mathematics, and lack of confidence, and which are
influenced by environmental factors (Baloglu & Kocak, 2006; Belbase, 2013; Buckley & Reid, 2013; Cemen, 1987). Mathematics anxiety negatively affects students’ participation and engagement with mathematics (Hembree, 1990), and can result in low self-esteem and self-efficacy (Bandura, 1993; Safford-Ramus, 2018; Usher & Pajares, 2008), as well as reduced performance in respect of mathematics (Jameson, 2010). As a consequence, the student may harbour feelings of self-doubt (Cemen, 1987), and hold a perception that he/she is no good at mathematics, or not able to do mathematics, particularly if the student’s previous engagement with mathematics has resulted in failure, and especially repeated failure (Ma & Xu, 2004; Zeidner, 2007) in situations of examination or testing (Alexander & Martray, 1989). The student may have poor study skills, as well as being insufficiently prepared for tests (Chinn, 2017; Spielberger & Vagg, 1995). The student may not have understood the content in the intended way, what Illeris calls ‘mislearning’ (Illeris, 2007: p. 148), with the result that the student did not grasp the concept or understand what should have been learned (Illeris, 2007). Where such mislearning is unresolved, it can result in the student developing “correct and mistaken understandings” of the mathematics content leading to the student giving up and believing they cannot understand mathematics (Illeris, 2007: p. 150). In this situation the student may resort to rote learning in order to ‘grasp’ the concept (Illeris, 2007).

Further, there is a perception that mathematics is a male domain (Cemen, 1987), with mathematics being the forte of boys that can have a detrimental impact on the intentions of female students in their pursuit of mathematics (Elton & Rose, 1967; Steele, 1997; Wilder, 2013); avoidance of mathematics and mathematics-related subjects – particularly within degree programmes – is a consequence (Safford-Ramus, 2018), but significant levels of mathematics anxiety can lead to both males and females avoiding mathematics, thereby limiting career opportunities (Safford-Ramus, 2018; Wilder, 2013).

**2.2.3 Situational Antecedents**

Situational antecedents comprise more immediate issues pertaining to the stimulus, including the nature of the mathematics task being done, the classroom environment, the method of instruction, and anxiety around the testing or evaluation of mathematics (Baloglu & Kocak, 2006; Belbase, 2013; Buckley & Reid, 2013; Cemen, 1987). The context for engagement with mathematics may present a stressor (Cemen, 1987), and the combination of stressor and mathematical task may impact negatively upon the student’s
self-esteem, leading to a mathematics anxiety reaction (Cemen, 1987). Buxton (1991) identifies three such circumstances: first, the presence of an authority figure, namely, a person who is likely to make a judgement concerning right and wrong; second, the emphasis on speed or a time limitation, particularly in the testing of mathematics, and in the presence of an authority figure; and third, is the public setting of the classroom in the midst of the other students, and the prospect of doing or answering a mathematics question in front of the others. In addition, certain mathematics topics, such as algebra, fractions and geometry, may pose more of a threat to the successful – and successive – development (Boaler, 2016; Chinn, 2017; Gough 1954) of a student’s mathematics knowledge. This is particularly so if a student misses out on one or more of these due to absenteeism (Chinn, 2017; Gough, 1954).

In summary, Cemen’s Model of a Mathematics Anxiety Reaction presents three sets of antecedents that facilitate a teasing out of the many incidents and life contexts whereby a student engages with mathematics, i.e. from past experiences pertaining to the school context, the involvement of parents, teachers, and peers, and how they can influence the student’s disposition, and the consequent impact on their engagement with mathematics, right through to the current situational factors that trigger the stressful situation that leads to the mathematics anxiety reaction (Cemen, 1987). Drawing on the three sets of antecedents, the following sections build on the above discussion and, framed by Cemen’s themes and sub-themes for each set of antecedents (Appendix B), explore these contributing factors to mathematics anxiety in more detail.

2.3 Environmental Antecedents Contributing to Mathematics Anxiety

The following section presents a review of the literature in respect of those environmental antecedents that contribute to mathematics anxiety; these include the influence of parents, the role of the teacher, and peers, and mathematics as a subject in primary and secondary school.

2.3.1 Influence of Parents

Parental engagement that supports their child’s learning impacts positively on their children’s engagement with schooling and their children’s learning overall (Goodall et al., 2017; Harris & Goodall, 2007); in particular, the passing on of parents’ positive attitudes towards learning is conducive to their children’s levels of achievement (Goodall
et al., 2017) and motivation to succeed (Bandura, 1993; OECD, 2013). In respect of mathematics, parents play an important role in the formation of their children’s attitudes towards the subject (Batchelor, Gilmore & Inglis, 2017), and the nature and extent of parental involvement has a significant impact on their children’s attitude to the subject and self-concept of mathematics (Goodall et al., 2017; McMullen & DeAbreu, 2011; Russell, 2009). However, parents may harbour a variety of attitudes to mathematics, based on their own – sometimes negative and traumatic – experiences of mathematics at school (Goodall et al., 2017; Scarpello, 2007), which may influence the nature of the support given to their children (Russell, 2009); parents may be highly mathematics anxious, and believe that mathematics is a difficult subject and only accessible to the brightest students (Gundersen, Ramirez, Levine & Beilock, 2012; Zaslavsky, 1994), and particularly that mathematics is the forte of boys (Geist & King, 2008). Parents may also be unfamiliar with up-to-date mathematics teaching methodologies and consequently feel inadequate towards helping their children with homework (Russell, 2009).

Alternatively, parents may have more constructive motivations for helping their children, including being able to provide the required mathematics knowledge, keeping their child one step ahead of the class, or awareness of the importance of mathematics to get on in life (Russell, 2009). Research by Maloney, Ramirez, Gunderson, Levine & Beilock (2015) contends that where the parent is mathematics anxious, or has a tendency to avoid situations involving mathematics, the parent runs the risk of negatively impacting upon their child’s learning of mathematics by conveying a negative impression of the subject; in this regard Maloney and colleagues advise that parents receive support in advance of being able to help their children with mathematics homework (Maloney, Ramirez, Gunderson, Levine & Beilock, 2015). Morkoyunlu, Konyalioglu and Gedik (2018) advocate the need for parents to get more involved in their children’s mathematics education by gaining more knowledge and guidance about their children’s mathematics in order to help them; in this regard, the delivery of dedicated mathematics seminars and short courses on how to help their children would benefit parents (Morkoyunlu, Konyalioglu & Gedik, 2018) resulting in a greater understanding and appreciation of mathematics, and leading to a positive effect on their children (Safford-Ramus, Misra & Maguire, 2016).

Before they start pre-school, children are influenced by the attitudes of their parents towards mathematics; exposure to a parent’s fixed mindset (Boaler, 2016; Dweck, 2006)
or negative outlook towards mathematics in the home can impact children’s inclinations towards mathematics from an early age (Geist, 2010). However, parental involvement in their children’s learning contributes to the intellectual growth of their children (Bandura, 1993) and can be conducive to increasing confidence in their children towards the learning of mathematics and the development of positive attitudes towards the subject (Jameson, 2010; Russell, 2009), particularly among girls (Zaslavsky, 1994). The role of the mother is significant in communicating “implicit attitudes” to her children (Lane, 2011, cited in Gunderson et al., 2012: p. 194), and in positively supporting her children’s mathematics education throughout their schooling (Morkoyunlu, Konyalioglu and Gedik, 2018). Recent research by Gunderson, Donnellan, Robins & Trzesniewski (2018) found that parental praise in respect of the learning process was positively related to achievement of learning goals, while parental criticism focusing on the person was negatively related to achievement of learning goals. Research by Vukovic and colleagues (2013b) has found that parental involvement can have an influence on their children’s mathematics achievement, by helping to reduce mathematics anxiety in situations involving word problems and algebra. To that end, Vukovic and colleagues advocate supporting parents in the creation of learning environments in the home that are conducive to supporting their children to be successful in mathematics, and less mathematics anxious (Vukovic et al., 2013b).

2.3.2 Influence of the Teacher

Early research into mathematics anxiety makes reference to the role of the teacher in contributing towards the student’s experience of mathematics. A patient and encouraging teacher can prevent negative attitudes towards mathematics developing among students (Ganley & McGraw, 2016; Gough, 1954). As the most important resource for students (Boaler, 2016), the teacher is instrumental in the conveyance of attitudes towards mathematics to students in the classroom environment (Gunderson et al., 2012; Maloney & Beilock, 2012); however, if the teacher himself/herself has a negative attitude towards mathematics, this can be passed on to some students, negatively impacting upon their engagement with mathematics (Hadfield & McNeil, 1994; Maloney & Beilock, 2012; Perry, 2004). The teacher’s instructional behaviour – both overt (observable) and covert (veiled) behaviour – may also have a bearing on how students take to mathematics (Geist, 2010; Jackson & Leffingwell, 1999), and where punishment is inflicted by the teacher, particularly after failure, evidence has shown a positive correlation with anxiety (Frenzel,
The teacher may not fully understand mathematics or may not like teaching mathematics (Dutton, 1954; Vukovic et al., 2013a); they may have had inadequate instruction in mathematics in their initial teacher education programmes (Paulos, 1988; Perry, 2004) or may have mathematics anxiety themselves (Liu, 2016). If the teacher has anxiety towards mathematics, it is likely that this will be conveyed to their students (Swards, Daane & Giesien, 2003; Wood, 1988). Research on female teachers admitting high levels of mathematics anxiety has demonstrated a negative impact on female students (Beilock, Gunderson, Ramirez & Levine, 2010; Gunderson et al. 2012).

Despite endeavours to promote newer approaches to teaching mathematics, traditional teaching methodologies are frequently and commonly employed to teach mathematics (Dutton, 1954; Earle & Rickard, 2018; Geist, 2010; Geist & King, 2008), advocating a one-size-fits-all approach to mathematics learning, emphasising learning at a procedural rather than conceptual level, fuelling rote-learning and memorisation, and under timed conditions (Boaler, 2016; Haylock, 2018). The intention here is to try to get students to attain a certain level in mathematics rather than emphasising understanding mathematics (Finlayson, 2014), an approach which does not address differences in learning styles and abilities among the learners (Boaler, 2016; Finlayson, 2014; Geist & King, 2008), and without regard to the existence of mathematics anxiety among learners (McLeod, 1992; Zan et al., 2006). Further, the teacher’s timely awareness of a student’s learning disability, such as dyslexia or dyscalculia, and the impact this may have on the student’s engagement with mathematics is pivotal in ensuring the right resources are made available to the student (Ansari, 2013; Mazzocco, 2007). Teacher expectation in respect of student achievement may also impact on how students engage with mathematics; where teachers hold particular beliefs about students, students’ performance can be affected accordingly, i.e. with such beliefs being influenced by demographic factors – including gender, ethnicity, and social class – or stereotypes having a moderating effect on teacher expectation (Jussim, Eccles & Madon, 1996). However, the more information the teacher has on each student, the less likely the teacher is to rely on stereotypes (Jussim et al., 1996).

The effectiveness of teacher instruction can be impacted upon by inadequacy of resources for mathematics teaching and learning, such as text books and other materials conducive
to meeting the needs of the variety of student abilities and learning styles in the classroom (Vukovic et al., 2013a). On the other hand, the experience of inadequate instruction in mathematics may result in student anxieties about mathematics (Wilbert, 2008). Where the mathematics classroom environment is one of fear, dread, excessive tension or provoking nervousness in respect of mathematics, the students’ interests are not being met (Ho, Senturk, Lam, Zimmer, Hong, Okamoto & Wang, 2000). Where a competitive element is fostered within the classroom, it gives rise to students focusing on attaining grades, more so than understanding concepts, and relying on the teacher in particular for affirmation in respect of how they are approaching mathematics (Solomon & Croft, 2016). Additional unhelpful factors include teacher insensitivity towards students, conveyance of the belief that there is a single correct answer to each mathematics problem posed, with contradictory results not being permitted (Allen, 2016; Boaler, 2016), and an emphasis on cumulative learning (Illeris, 2007) – rigid rote learning and memorisation – rather than fostering accommodative learning (Illeris, 2007) or critical thinking (Bishop, 1999; Geist, 2010; Hadfield & McNeil, 1994; Illeris, 2007; Perry, 2004). The culmination of numerous negative experiences of mathematics may lead to students disengaging with the subject and developing an indifference to achievement in mathematics (Jussim et al., 1996; Perry, 2004).

2.3.3 Influence of Peers

The influence of one’s peers is significant in the study of mathematics anxiety, in that students tend to frequent with others with similar interests, including attitudes towards mathematics (Aiken, 1976). Students are drawn towards others with similar attitudes to themselves (Frank, Muller, Schiller, Riegle-Crumb, Strassmann Mueller, Crosnoe & Pearson, 2008). Research into the impact of peers on the attitudes and academic achievement of their friends identified the impact of peer support – especially among girls – as well as home support (more prevalent among boys) on student attitudes and achievement (Frank et al., 2008; Fraser & Kahle, 2007). If mathematics is seen to be a male domain (Frank et al., 2008) girls may seek the support of their female friends and peers regarding their behaviour towards mathematics (Frank et al., 2008). Teenage boys are more likely to rely on their peer group and popular media for sources of information (Chambers & Schreiber, 2004). The value placed on mathematics also has an influence on the effects of performance in mathematics, and on a student’s mathematics anxiety (Frank et al., 2008; Wigfield and Meece, 1988). Where there is an emphasis on
competition within the classroom, the focus is largely on the achievement of grades rather than on understanding of concepts (Solomon & Croft, 2016), and there is awareness among peers that success in mathematics for some means failure for others, resulting in an adverse impact on engagement and achievement (Frenzel et al., 2007).

2.3.4 School Mathematics and Mathematics Anxiety

Mathematics anxiety affects students at all levels of the education system; primary (Stodolsky, 1985; Eden, Heine & Jacobs, 2013; Ramirez, Gunderson, Levine & Beilock, 2013; Boaler, 2016), secondary (Wigfield & Meece, 1988; Chinn, 2017), further education (Betz, 1978; Boaler, 2016), and higher education (Alexander & Cobb, 1984; Allen & Allen, 2010; Ashcraft & Moore, 2009; Bessant, 1995; Betz, 1978; Clute, 1984; Hembree, 1990; High, 2000; Hunt, Clark-Carter & Sheffield, 2011; Lyons & Beilock, 2012; Sheffield & Hunt, 2007; Taylor & Galligan, 2006), with much research having been conducted on pre-service teachers (Ashcraft & Krause, 2007; Aslan, 2013; Belbase, 2013; Gresham, 2009, 2016; Haylock, 2018; Hembree, 1990; Stoehr, 2015). The existence of mathematics anxiety has only recently been traced back to early primary or elementary school, with evidence of varying levels of anxiety towards mathematics at first grade being reported by pupils, as well as showing a negative correlation to their achievement in the subject (Maloney & Beilock, 2012; Ramirez et al., 2013; Ganley & McGraw, 2016). Certain topics at primary level seem to present challenges for children; these include times tables, fractions, carrying, and more abstract concepts like algebra (Dowker, 2017; Earle & Rickard, 2018). The early years of school, including pre-school and early primary school, represent the formative years in acquiring the basic skills in – and attitudes towards – mathematics (Aiken, 1976; Boaler, 2016; Maloney & Beilock, 2012; NCCA, 2015), and some research suggests that mathematics anxiety does not exist before children start school, but evolves during school years (Ashcraft et al., 2007; Beilock et al., 2010; Newstead, 1998); however, children may enter school predisposed to negative feelings towards mathematics attributable to environmental factors (Harari et al., 2013). Thus, the school environment and the teaching methods used can make all the difference in how a student grasps mathematical concepts at primary school, and in this regard, the teacher is pivotal in portraying the right attitude towards mathematics (Macrae, 2003).
The inability of primary level children to appropriately express their fear and anxiety towards mathematics is a likely factor in the omission of research into mathematics anxiety among primary school children (Chaman et al., 2014; Ganley & McGraw, 2016). In addition, the nature of instrument used to measure the level of mathematics anxiety – with Likert-type scales – is not reported as having been widely used at primary level, and may not have suited primary level children’s ability to express their feelings about mathematics (Chaman, Beswick & Callingham, 2014); this has more recently been addressed with the use of pictorial scales in Likert-type tests on mathematics anxiety for children (Ganley & McGraw, 2016; Ramirez et al., 2013). Further, in a large scale study by Brown, Askew, Rhodes, Denvir, Ranson & Wiliam (2001) in the United Kingdom, the findings revealed that primary school teachers frequently advocate that students’ approach to mathematics should be prompt, and not involve any struggle, and those who were referred to as the best at mathematics were those students who were able to grasp concepts easily and able to complete tasks quickly (Brown, Askew, Rhodes, Denvir, Ranson & Wiliam, 2001). The need to enhance interest and skills in mathematics during the early years of schooling is central to enhancing primary school students’ engagement with mathematics and in this regard a review of teaching methods at primary level is central to ensuring more positive attitudes prevail (Smyth, 2017).

Prior to the association of mathematics anxiety with primary school children, it had been claimed that the onset of mathematics anxiety coincided with the learning of abstract concepts, such as algebra, within the secondary school curriculum (Ashcraft & Krause, 2007; Maloney & Beilock, 2012; Wigfield & Meece, 1988), as well as being faced with a situation of evaluation of their ability to perform a mathematical task (Pletzer, Wood, Scherndl, Kerschmbaum & Nuerk, 2016; Wilder, 2013); consequently, Wigfield and Meece (1988) acknowledged the need for interventions at primary school and at home to counteract the issues that would lead to the onset of mathematics anxiety – or mathematics anxiety becoming “strongly established” (Wigfield & Meece, 1998: p. 215) – particularly in the early years of secondary education, or middle school (Ashcraft & Moore, 2009).

The transition to secondary school poses many challenges for incoming students who have left behind a primary school environment with typically one class teacher and are now faced with many subject-specific teachers with different teaching methods to those encountered previously (Smyth, 2017). In the Irish context, the transition process is also accompanied by anxiety – among some groups of students more than others, including
girls or those from disadvantaged or ethnic-minority backgrounds – and an impact on self-confidence (Smyth, 2017). In respect of mathematics, previous criticism of the difficulty in transitioning from primary to secondary school included the discontinuity between the curricula and having to deal with new terminology and procedures in mathematics (Galton, Morrison & Pell, 2000). More recently, research by O’Meara, Prendergast, Harbison and O’Hara (2017) found that gaps exist in sixth class primary teachers’ knowledge of the mathematics syllabus and pedagogical practices adopted in secondary school, and vice versa. This gap in knowledge can be detrimental in facilitating the transition process in mathematics and contribute to lower attainment levels (O’Meara, Prendergast, Harbison & O’Hara, 2017).

The organisation of mathematics curriculum content into linear strands rather than interconnected topics (Tobias, 1993) is a feature of mathematics education in many countries and has been criticised as not being reflective of real-world application of mathematics (Atweh & Goos, 2011; Burke, 2014; NCCA, 2016), leading to the call for and implementation of reforms of both primary and secondary school curricula in Ireland in the last decade (NCCA, 2006; NCCA, 2016). In Ireland, the absolutist tradition of mathematics had dictated the “abstract, formalist, and comparatively competitive character” (Oldham, 2001, in Lyons, et al., 2003: p. 4) of the secondary school mathematics curriculum. Preparation for the State Examinations, particularly the Leaving Certificate examination, was inclined to have prescribed what transpired in the mathematics classroom (Lyons, et al., 2003; Oldham, 2002), thereby determining the curriculum for mathematics (Isaacs, 2014), and resulting in an absence of debate on alternative approaches to teaching the subject (Lyons, et al., 2003).

Ireland’s Programme for International Student Assessment (hereafter PISA) test results have provided a worthwhile stimulus for debate on mathematics (Oldham, 2002), as well as for policy discussion (O’Donoghue, 2011; OECD, 2013); however, the significance of these results lies in their meaning and relevance to the local context and their association with national priorities for education, mathematics curricula, as well as considerations for the teaching and learning of mathematics on the ground (Oldham, 2002). Findings from the 2012 PISA tests showed that across the OECD countries, higher levels of mathematics anxiety are associated with overall lower scores in mathematics, equivalent to performance one year below the level tested (OECD, 2013). Further, reduction in mathematics anxiety levels corresponded with increases in performance and self-efficacy.
(Bandura, 1993; OECD, 2013). The identification of issues and problems with the second-level mathematics curriculum in Ireland did not surface solely as a result of the PISA tests, but rather emerged over a number of years and were highlighted in the findings of a number of endeavours, as summarised by Cosgrove, Perkins, Shiel, Fish & McGuinness (2012), including:

“research in Irish classrooms (Lyons, Lynch, Close, Sheerin & Boland, 2003), Chief Examiners’ reports (for the JC in 2003 and 2006, and for the LC in 2000, 2001, and 2005), the results of diagnostic testing of third-level undergraduate intake (Faulkner, Hannigan, & Gill, 2010), trends in international mathematics education (Conway & Sloane, 2006), and results of international assessments such as PISA (Cosgrove, et al., 2005).”

(Cosgrove et al., 2012: p. 7)

Collectively this evidence revealed considerable deficiencies in student’s understanding of mathematics as well as the application of mathematical knowledges to varied contexts outside of the use of procedural skills (Cosgrove et al., 2012). These deficiencies were seen as problematic, in that the student’s experience of mathematics at secondary school should be sufficient to equip students for life after school (NCCA, 2015). The culmination of each of the Junior and Senior cycles at second-level with a state examination has also been identified as contributing to the challenges with the mathematics curriculum (Looney, 2001; NCCA, 2012), particularly where at senior cycle there is a propensity to focus on the examination, repeating practice tests and guiding students to answer questions in a specific way (NCCA, 2012). Consequently, a concerted effort to address the shortfall in the secondary mathematics curriculum led to a number of measures, including the roll-out of Project Maths since 2010 (Ní Shúilleabháin, 2014) which adheres to the investigative and practical philosophy of the Realistic Mathematics Education (RME) approach to mathematics education; an approach which in other countries has resulted in enhanced students’ understanding of mathematical procedures, and has proved superior to the more traditional approaches to mathematics teaching and learning (Petocz & Reid, 2005; Skovsmose, 2011).

Further, the existence of ‘ability grouping’ or streaming in schools has contributed to the labelling of children as being weaker or stronger at mathematics by virtue of the class level they were part of (Boaler, 2016; Pokorny & Pokorny, 2005); in Ireland, for example, secondary school mathematics classes had been named ordinary (‘pass’) level and higher (‘honours’) level since the 1960s (Oldham, 2002), and in 1992 foundation level
mathematics was introduced as a third stream (SEC, 2015). Boaler (2016) contends that streaming of students into ability levels also has a long term detrimental effect on students’ mathematics learning, with students in lower level classes often being less motivated and resorting to bad behaviour (Boaler, 2016); the misbehaving student may also be bored or not effectively challenged (Frenzel et al., 2007). For many students, the ability grouping remains with them throughout their schooling, limiting future opportunities (Boaler, 2016).

2.3.5 Mathematics Achievement below Expectation

Where a student experiences higher levels of mathematics anxiety they are more likely to underperform in mathematics or even avoid mathematics (Ashcraft & Krause, 2007). In this regard the higher the student’s level of mathematics anxiety, the more likely their achievement will be below expectation, particularly with late primary school mathematics and beyond (Ashcraft & Krause, 2007). The knock-on effect is that higher mathematics anxious students are less motivated to do higher levels of mathematics and any additional mathematics beyond what is required of them (Ashcraft & Krause, 2007). In addition to many of the environmental factors mentioned above, underachievement in mathematics and not being able to learn from the mistakes made in mathematics tasks can lead to the student falling behind and ultimately being unable to catch up (Ashcraft & Krause, 2007; Boaler, 2016; Maloney, Schaeffer & Beilock, 2013). Further, where a student has missed school, for example due to illness, it may be very difficult to catch up on missed content, particularly if support is lacking from the school (Cemen, 1987; Kearney, 2008).

2.4 Dispositional Antecedents Contributing to Mathematics Anxiety

This section presents a review of the literature in respect of the dispositional antecedents – how mathematics anxiety impacts on the person; these include self-doubt, attitudes to mathematics, gender and mathematics anxiety, and avoidance of mathematics.

2.4.1 Effect on the Person

Mathematics anxiety relates to a person’s mental and emotional state in respect of doing mathematics and has been regarded as a psychological problem (Betz, 1978; Allen, 2016). The effect of mathematics anxiety on students has been compared with the effects of illness and disease, including the impact upon students’ mental balance and stability (Gough, 1954), and emotional disturbance around mathematics (Arem, 2010; Dreger &
Aiken, 1957; Hannula et al., 2004; Marshall, Mann & Wilson, 2016). Fennema and Sherman describe it as a dimension ranging from feeling at ease to feeling distinct anxiety (Fennema & Sherman, 1976). Dreger and Aiken (1957) use the word ‘syndrome’ as they contend there are numerous anxieties that contribute to the phenomenon (Dreger & Aiken, 1957). Zaslavsky (1994) also refers to mathematics anxiety as a ‘syndrome’ that impacts negatively on a student’s learning of mathematics, making it difficult or even impossible for the learner to use the math skills they already have. It can be latent (Lazarus, 1974; Krinzinger, Kaufmann & Willmes, 2009), or it can manifest itself through physical symptoms, such as nausea, headaches, heart palpitations, dry lips, pale face, and dizziness (Arem, 2010; Perry, 2004; Stoehr, 2017; Zaslavsky, 1994), the effects of which can be debilitating and traumatic for the student (Boaler, 2010; Zaslavsky, 1994); this is particularly evident in situations of mathematical evaluation or testing (Chinn, 2017; Hunt et al., 2011; Wilder, 2013; Zaslavsky, 1994) whereby the student perceives the situation involving mathematics as threatening (Buckley et al., 2016).

The intensity of mathematics anxiety experienced varies from one person to the next; this can range from less intense emotional reactions, such as dislike or worry, to more intense emotional reactions, such as fear or panic (McLeod, 1992; Chinn, 2017). In addition, emotional symptoms of mathematics anxiety may include lacking confidence in one’s ability, feeling helpless doing mathematics, and fear of getting the wrong answer or failure in mathematics (Marshall et al., 2016). While failure can lead some students to persevere towards a desired goal and work harder (Duckworth, Peterson, Matthews & Kelly, 2007; Dweck, 2017), Tobias likened failure in mathematics to “sudden death, [being] instant and frightening” (Tobias, 1993: p. 50) and often hindering the student from progressing with mathematics (Tobias, 1993); Cemen (1987) surmised that failure among high mathematics anxious students would result in the apportioning of blame to internal factors, such as their own inability in mathematics, while low mathematics anxious students would be inclined to blame external factors, such as the teacher. Buxton (1991) introduced the concept of ‘math panic’ as an extreme form of mathematics anxiety (Reyes, 1984), and describes the influence of pressures, particularly imposed authority, public exposure and time deadlines (Buxton, 1991: p. x), that iterate and finally culminate in a state of panic (Buxton, 1991). Beyond that critical point, according to Buxton, lies a state of panic which – in the context of what might be experienced in the mathematics classroom – may materialise as physical symptoms akin to paralysis, mental blocks, or a
 state of rigidity (Buxton, 1991). Arem (2010) acknowledges that mathematics anxiety takes time to materialise and asserts that the symptoms of mathematics anxiety are clear-cut, with adverse mental, and/or physical reactions to mathematical problem solving, which – she contends – have been caused by difficult experiences of mathematics during the course of the student’s life (Arem, 2010).

More recent research by Allen (2016) presents a distinction between mathematics anxiety and mathematics trauma and contends that the difference lies in the location of the problem; with mathematics anxiety the problem lies inside the person experiencing mathematics anxiety, while with mathematics trauma the problem stems from outside the individual, who had a traumatising experience (or experiences) and consequently is struggling with mathematics. Thus, the person suffering from mathematics anxiety needs to be ‘fixed’ while the person experiencing mathematics trauma must acknowledge that they had a traumatising experience and that they can move forward from this (Allen, 2016). The disparity in the range of reactions towards mathematics (Hart, 1989) gives rise to the need for clarity and consistency on the identification of mathematics anxiety among the individuals being investigated.

2.4.2 Self-Doubt and the Impact on Working Memory

Students who are mathematics anxious harbour inner worries and self-doubt (Ashcraft & Moore, 2009), which can be attributed to lack of confidence in one’s mathematical ability, or lack of interest in the subject (Zaslavsky, 1994), and which can impact adversely upon their working memory (LeFevre et al., 2005, cited in Ashcraft & Moore, 2009). The demands on working memory are significant for solving more advanced mathematical problems than simply memory retrieval (Ashcraft & Krause, 2007), including complex mathematical concepts, involving multiple stages and sequences to complete the problem, as well as handling larger numbers, intricate formulas and equations (Ashcraft & Moore, 2009). Anxious thoughts about the mathematics a student encounters occupy significant working memory space with negative thoughts about their attempt to solve the problem, as well as dealing with the worry of not succeeding with the problem, losing face in front of their teacher and peers, and surmising what others will think of them (Beilock & Willingham, 2014: p. 30). The more pronounced the effect of mathematics anxiety on working memory, the more negative the impact on learning and performance in mathematics (Ashcraft & Moore, 2009).
2.4.3 Impact of Mathematics Anxiety on Engagement with and Performance in Mathematics

As an outcome-directed emotion (Frenzel et al., 2007) mathematics anxiety occurs frequently in the context of learning and performance in mathematics (Frenzel et al., 2007). Learning mathematics is often a solitary endeavour, whereby the student works alone to solve a problem (Tobias, 1993), often in a timed, and competitive situation, with emphasis on getting the correct result, and usually one correct result (Boaler, 2016; Chinn, 2017; Tobias, 1993; emphasis added). The lack of context for and abstractness of some mathematics concepts can add to the struggling student’s disorientation with mathematics (Boaler, 2016; Chinn, 2017). Mathematics anxiety poses a threat to performance and consequently achievement in mathematics. When they are confronted with numbers and mathematical information students with mathematics anxiety can perform poorly (Ashcraft & Krause, 2007; Evans, 2000; Maloney & Beilock, 2012; Wigfield & Meece, 1988; Wilbert, 2008). Students with higher levels of mathematics anxiety often underperform only in mathematics, and not in other subjects (Maloney et al., 2013).

Students can experience distress as a result of their perceived inability to cope with the mathematics theory they encounter (Klinger, 2011). The presence of a mathematical problem can result in the mathematics anxious student worrying about the situation facing them, as well as the consequences, leading to a deterioration in their performance. This anxiety can hinder students’ achievement in mathematics, despite their actual ability in mathematics (Boaler, 2016; Maloney & Beilock, 2012). Moreover, final grades in mathematics may not adequately reflect achievement in mathematics (Aiken & Dreger, 1961), as mathematics anxiety can disguise a student’s true ability in the subject (Ashcraft & Moore, 2009). Mathematics anxiety has a detrimental effect on cognitive processing by using resources to manage the body’s response to the anxiety (Ashcraft et al., 2007).

When highly mathematics anxious students avail of treatment for mathematics anxiety the results show an improvement in performance comparable to that experienced by individuals with low mathematics anxiety (Dowker, Sarkar, Looi, 2016; Hembree, 1990).

Much research into mathematics anxiety has explored the relationship between mathematics anxiety and performance in mathematics; first, mathematics anxiety is responsible for poor performance in mathematics (Dreger & Aiken, 1957; Betz, 1978; Wilder, 2013) when it affects a student’s ability to learn mathematics (Betz, 1978; Boaler, 2016; Chinn, 2017; Miller & Bichsel, 2004); second, poor performance in mathematics
can give rise to mathematics anxiety (Ashcraft et al., 2007); third, the relationship can be reciprocal, with poor performance giving rise to anxiety, which in turn impedes subsequent performance (Ashcraft et al., 2007). Carey, Devine, Hill and Szűcs (2017) label three ways of looking at these interactions as: the Deficit Theory, where poor performance in mathematics causes the student to be more anxious about subsequent engagement with mathematics; the Debilitating Anxiety Model, where mathematics anxiety impacts performance in mathematics at “the stages of pre-processing, processing, and retrieval of mathematics knowledge” (Carey, Devine, Hill & Szűcs, 2017: p. 3); and the Reciprocal Theory proposed by Ashcraft and colleagues (2007), where mathematics anxiety can emerge as a result of the influence of non-performance related issues – i.e. biological disposition – or because of performance deficits, and can be further exacerbated by poor performance, leading to disruption of working memory, and avoidance of mathematics, resulting in a vicious cycle (Carey et al., 2017). Different studies have given results supporting either the Deficit Theory or the Debilitating Anxiety Model, which Carey and colleagues (2017) contend can have implications for mathematics teaching and policy on mathematics education. Studies adhering to the Deficit Theory tend to be longitudinal in nature, while those observing the Debilitating Anxiety Model are by contrast short-term. However, Carey and colleagues (2017) advocate the need for further, particularly longitudinal research including mixed methods research into exploring each of these three ways of looking at the relationship between mathematics anxiety and performance in mathematics, and to ascertain which develops first.

2.4.4 Attitude to Mathematics

The consideration of affective factors – beliefs, attitudes, emotions (McLeod, 1992) and values (DeBellis & Goldin, 1997, in Zan et al., 2006; DeBellis & Goldin, 2006) – in respect of mathematics education has gained significance in the study of mathematics anxiety in recent decades (Zan et al., 2006). McLeod (1992) advocates the importance of the first three in research into mathematical instruction and performance of students, particularly from a young age. DeBellis and Goldin (2006) advanced McLeod’s research to include values to interpret mathematics students’ behaviour when engaged with mathematics problems (McLeod, 1989; Zan et al., 2006). In the context of mathematics education McLeod (1989) presents beliefs, attitudes and emotions in that order, representing “increasing affective involvement, decreasing cognitive involvement,
increasing intensity, and decreasing stability” (McLeod, 1989: p. 246); thus, beliefs represent the most stable, least intense factor, having developed over time; attitudes are moderately stable, moderately intense; and emotions are the least stable, most intense (DeBellis & Goldin, 2006; Kleanthous & Williams, 2013; McLeod, 1992; Zan et al., 2006), change rapidly (DeBellis & Goldin, 2006; McLeod, 1992), have a higher intensity than attitude (Evans, 2000), and emotional responses to mathematics contribute to the formation of attitudes on mathematics (Evans, 2000; McLeod, 1992; Zan et al., 2006). The significance of values in mathematics education stems from “deep affective qualities” (Bishop, 1999: p. 232) with a long-lasting impact on students, particularly where these values are negative, and subsequently contribute to negative perceptions of mathematics, which in turn can be conveyed through parental influence (Bishop, 1999), as well as being influenced by external factors of culture, society and environment (DeBellis & Goldin, 2006).

The beliefs held by students in respect of mathematics are central to the formation of attitudes and resulting emotions experienced by the students; where students perceive that mathematics is difficult, governed by rules, must be completed within a given time, and a significant subject for their success and career advancement (Hembree, 1990) as well as enrolment into many higher education programmes (Johnson & O’Keeffe, 2016), they are likely to have a more intense reaction to their engagement with the subject (Chinn, 2017; McLeod, 1992). In a recent Irish study Smyth (2017) found that secondary school students with negative attitudes towards mathematics were more negative about their engagement with school in general. In this regard, McLeod is critical of mathematics curricula which – he contends – can encourage adverse beliefs about mathematics (McLeod, 1992). This viewpoint is also echoed by Tobias (1993) who asserts that the content of mathematics curricula poses challenges for students, particularly where mathematics is perceived as not being relevant to the real world or not related to other subjects, and when more abstract concepts are introduced, with special notation and symbols to represent concepts (Tobias, 1993). Thus, the requirement of multi-step procedures and complex calculations, the use of abstractions and symbols, as well as the negotiation of formulas and equations add to the challenges posed by mathematics curricula (Ashcraft & Krause, 2007; Ashcraft & Moore, 2009; Haylock, 2018).
2.4.5 Mathematics Anxiety and Gender

Many studies in the research into mathematics anxiety among students report higher levels of mathematics anxiety among females than males (Ashcraft & Faust, 1994; Baloglu & Kocak, 2006; Betz, 1978; Hembree, 1990, Hopko, 2003); however, others have found no gender difference (Cooper & Robinson, 1991; Wilder, 2013). Hembree (1990) found that although female high school students report mathematics anxiety more than their male counterparts in terms of mathematics avoidance and performance in mathematics, the male students demonstrated more anxiety in both these situations. More recently, Devine, Fawcett, Szucs & Dowker (2012) reported no gender difference in mathematics performance of second level students despite girls reporting higher levels of mathematics anxiety. Other studies showed no significant relation between mathematics anxiety and age, or between mathematics anxiety and performance (Ma, 1999; Meece, Wigfield & Eccles, 1990; Wu, Barth, Amin, Malcarne, Menon, 2012), with mixed findings in respect of mathematics anxiety and gender (Evans, 2000; Hopko, Mahadevan, Bare & Hunt, 2003).

Male students tend to exhibit more confidence and give themselves higher self-ratings than females in a number of domains (Beyer & Bowden, 1997; Jakobsson, Levin & Kotsadam, 2013) including mathematics, thereby contributing to gender differences in respect of mathematics anxiety (Dowker et al., 2016). Some research reports that females are more likely to express their anxiety about mathematics and rate themselves lower in mathematics ability (Devine et al., 2012; Dowker et al., 2016; Hembree, 1990; Wigfield & Meece, 1988); for example, the prospect of a mathematics test can result in expressions of anxiety among students (Chinn, 2017; Miller & Bichsel, 2004), especially female students (Devine et al., 2012; Hembree, 1990; Miller & Bichsel, 2004; Wigfield & Meece, 1988), and older female students (Betz, 1978; Hembree, 1990; Miller & Bichsel, 2004) especially where the test involves applied mathematics (Miller & Bichsel, 2004). Female mature students are more likely to express their anxiety towards mathematics compared with female traditional students. A contributing factor is likely the time lapse since they last encountered school mathematics (Fleming & Murphy, 1997); in addition, the level of preparation of mathematics at high school has a strong influence on the level of anxiety experienced subsequently (Betz, 1978; Finlayson, 2014).

The effects of negative stereotypes, or stereotype threat (Steele, 1997) whereby women allegedly perform poorer in mathematics (Ashcraft & Moore, 2009; Beilock et al., 2010),
and the perception of mathematics as a “masculine activity” (Elton & Rose, 1967: p. 538) can lead to avoidance by girls of mathematics (Elton & Rose, 1967; Steele, 1997; Wilder, 2013). In addition, Gunderson and colleagues (2012) argue that parents’ and teachers’ expectations in light of the child’s success with mathematics are biased by their own gender stereotypes and can impact negatively on achievement and self-concept in mathematics, particularly for girls. Male students may also succumb to “stereotype lift” (Smith & White, 2002, cited in Smith, 2006: p. 294), whereby their awareness of a mathematics gender stereotype may result in those male students – particularly those with an aptitude for mathematics – performing better; while those male students who are less competent or interested in mathematics may fall victim of the stereotype lift and have impeded performance and motivation (Smith, 2006).

2.4.6 Avoidance of Mathematics

A student’s tendency to avoid engaging with their learning of a subject stems from their perceived inability to do well, and their intention to preserve their self-worth by employing strategies that deflect attention from their inability (Covington, 1992; Turner et al., 2002). Students tend to use avoidance strategies in learning environments that are lacking fun and enthusiasm for learning and understanding, and where there is a disjoint between the cognitive and affective aspects of teaching and learning, where teachers are unlikely to be supportive through instruction or motivationally, giving limited attention to building understanding among students (Boaler, 2016; Turner et al., 2002). Repeated experiences of these situations lead to the student avoiding tasks they see as threatening, resulting in a detrimental impact on progress and achievement (Fletcher & Cassady, 2010). Avoidance strategies, while not uncommon in childhood, are more evident from early adolescence whereby there is a perception that ability is fixed rather than modifiable (Covington, 1992; Dweck, 2017); these typically include not putting in effort, not wanting to try new approaches to doing the subject, and not seeking help with the subject (Boaler, 2016; Fletcher & Cassady, 2010; Turner et al., 2002).

Negative experiences with mathematics and the existence of mathematics anxiety may lead to avoidance behaviour that impacts negatively on the student’s academic progression (Ashcraft & Moore, 2009; Finlayson, 2014; Jackson & Leffingwell, 1999), including engaging with the subject at a level conducive to them meeting the minimum programme requirements (Ashcraft & Krause, 2007; Betz, 1978). Avoidance of
mathematics entails withdrawing from learning situations that contribute to the student thinking negatively about mathematics and the development of negative attitudes towards the subject (Fletcher & Cassady, 2010; Ibrahim, 2018). There is a preference for a mathematics avoider (Langpaap, 2005) not to have to engage with mathematics at all either academically or in everyday situations. Their avoidance of mathematics can be fuelled by exposure to negative talk about mathematics by others, including in the media (Johnston-Wilder & Lee, 2017). However, many undergraduate courses contain mathematics modules which may not be evident from the titles, thereby deceiving the prospective student (Fitzmaurice et al., 2015).

Not understanding the mathematics content they are faced with leads some learners to avoid seeking help, and for more learners they prefer to do nothing rather than seeing their attempts resulting in failure (Chinn, 2017; Turner et al., 2002; Whitton, 2018). Avoidance of mathematics heavy courses of study (Wilder, 2013) – by female or male students – as a consequence of mathematics anxiety can lead to a global avoidance approach to mathematics (Ashcraft & Krause, 2007) including avoiding mathematics classes and resulting in a restriction of career choices and vocational opportunities (Ashcraft & Krause, 2007; Betz, 1978; Hopko et al., 2003; Wilder, 2013).

2.5 Situational Antecedents Contributing to Mathematics Anxiety

This section presents a review of the literature in respect of situational antecedents; these include the nature of service mathematics, classroom factors, the way mathematics is taught, and anxiety in the test situation.

2.5.1 The Nature of Service Mathematics and Mathematics Anxiety

An increasing number of students entering higher education programmes are required to take modules in mathematics and/or statistics (Lawson Croft, & Halpin, 2003; Tobias, 1993) referred to as ‘service mathematics’ (Gill & O’Donoghue, 2005; Hawkes & Savage, 2000, cited in Parsons, Croft & Harrison, 2011) where mathematics is a component of study, comprising an essential component of the degree (Macbean, 2004) but not the main discipline of study (Gill & O’Donoghue, 2008), for example, a business mathematics module as part of a business studies degree. Certain disciplines, such as science or engineering, are synonymous with having considerable mathematics content as part of the programme of study (Fitzmaurice et al., 2015; Hembree, 1990; Kargar,
Rohani Ahmed & Bayate, 2010), and an increase in the use of statistics in many disciplines necessitates that engagement with the subject is unavoidable (Marshall et al., 2016). The presence of a service mathematics module within a programme of study may come as a surprise to some students, who did not anticipate mathematics being a required module, or who had been deceived by the name of the mathematics module in the programme prospectus, for example, quantitative methods (Fitzmaurice et al., 2015). Also, students may not be aware of the extent of the mathematics content in a programme of study (Fitzmaurice et al., 2015; Ryan & Fitzmaurice, 2017), or may choose programmes of study that have a minimal amount of mathematics or do not have a mathematics component (Betz, 1978; Boaler, 2016), thereby limiting their choices when applying to study programmes in further or higher education (Betz, 1978; Chinn, 2016; Fiore, 1999).

The under-preparedness of many students (Hunt & Lawson, 1996; Taylor & Galligan, 2006; Gill & O’Donoghue, 2008) taking service mathematics – referred to as the ‘mathematics problem’ (Hunt & Lawson, 1996) – may have a bearing on some students transitioning to higher education, posing a challenge for lecturers of mathematics across the sector (Kyle & Kahn, 2009; Morton, 2009), particularly those teaching service mathematics both at Universities and Institutes of Technology (Fitzmaurice et al., 2015). For some students, the ‘mathematics problem’ can be exacerbated, particularly if a student’s previous experience of mathematics has been negative, resulting in mathematics anxiety (Klinger, 2006; Macrae, 2003; Wilbert, 2008). The response of higher education institutions to the ‘mathematics problem’ can be instrumental in facilitating students’ transition from second level mathematics, with efforts to accommodate students with levels of support reflecting where the students are positioned with respect to their engagement with mathematics (Johnson & O’Keeffe, 2016; Kyle & Kahn, 2009) and an emphasis on proactive communication between lecturer and student, as well as among students (Luk, 2005; Selden, 2005); these approaches are favoured as they help to instil good feelings towards mathematics among students (Luk, 2005). In addition, many students resort to using online resources to supplement their learning using, for example, Massive Open Online Courses (MOOCs), YouTube and Khan Academy to assist with mathematics learning. This can lead to changes in mindset and subsequently improved achievement (Boaler et al., 2018), as well as facilitating understanding – particularly for visual learners –, presentation of context, and clarification of topics at a level and pace
suited to the student (Jackman & Roberts, 2014; Thompson, 2011; Zengin, 2017). However, despite the availability of comprehensive online resources and students’ willingness to utilise these, many mature students in particular prefer the interpersonal contact with lecturing staff (Breen, Prendergast & Carr, 2015).

2.5.2 Classroom Factors

Engagement with service mathematics at higher education can pose challenges for the student, particularly in terms of the module content, the teaching and learning environment, the instruction style of the lecturer and the level of preparation expected of the student (Morton, 2009). The interaction between student and teacher or lecturer has been identified as a contributing factor to mathematics anxiety (Ashcraft & Krause, 2007; Dreger & Aiken, 1961; Vukovic et al., 2013a; Wigfield & Meece, 1988), and in this regard, the lecturer’s personality conveying approval and a positive attitude towards service mathematics play a significant role in making students feel comfortable with mathematics, thereby reducing the threat to the students’ self-esteem (Cemen, 1987; Gunderson et al., 2012; Maloney & Beilock, 2012).

Service mathematics is typically delivered using a combination of formal lectures and tutorials (Kyle & Kahn, 2009), as well as online methods (Thompson, 2011), and more recently the flipped classroom approach (Bergmann & Sams, 2012; Zengin, 2017). The result is that the onus is increasingly put on the student to prepare much material outside of formal contact hours as groundwork for subsequent classes (Bergmann & Sams, 2012; Selden, 2005), which typically continue by building on, but not necessarily revising previously discussed concepts. In this regard, the new student’s experiences of service mathematics, for example large lecture sizes, faster pace, and a substantial volume of materials, including online resources, can be far removed from their experiences of school (O’Donoghue, 1999), and even more so if the student has enrolled as a mature student (Faulkner, Fitzmaurice & Hannigan, 2016).

2.5.3 The Way Mathematics is Taught

The instruction style of the lecturer is likely to differ considerably from that experienced by the student of the teacher in the school environment (Kyle & Kahn, 2009); furthermore if the lecturer is new to the role, they may rely on using methods they themselves would have experienced as students and which are easy for them to pick up, rather than taking the learning needs of the student group into account (Bartlett, 1995). The presentation of
mathematics as a set of rules, formulae, and procedures, particularly without reference to context (Boaler, 1997, 2015; Cemen, 1987; Kyle & Kahn, 2009; Schoenfeld, 1989), and the focus of working towards the mathematics examination at the end of the academic term or year consolidates the perception of mathematics as a rigid, difficult subject (Kyle & Kahn, 2009; NCCA, 2006; Prendergast, 2011).

The fact that a student does not ‘get’ or understand a mathematics problem can remain hidden, with the unfamiliar content accumulating and without the lecturer being aware of such challenges facing the student (Boaler, 2010; Tobias, 1993). Such conditions are conducive to the existence of an atmosphere of tension or worry among students (Tobias, 1993), which may also be detrimental to – and hinder – performance (Betz, 1978; Evans, 2000; Ganley & McGraw, 2016; Hembree, 1990; Wigfield & Meece, 1988; Zaslavsky, 1994). In contrast, for some students worrying about the prospect of not succeeding with mathematics may help motivate them to try harder (Evans, 2000; Wigfield & Meece, 1988) by inciting them to focus on getting the task done through increased effort rather than inhibiting performance (Henschel & Roick, 2018). The collective impact of these experiences may result in students feeling unable to do mathematics (Boaler, 2016; Zaslavsky, 1994), that mathematics is beyond their capability (Boaler, 2016; Tobias, 1993; Zaslavsky, 1994), apportioning blame on external causes – for example, the teacher or the subject itself – or internal causes – for example, their own inability to do mathematics (Cemen, 1987; Whitten, 2018), and not wanting to pursue further mathematics courses (LeFevre, Kulak & Heyman, 1992; Whitton, 2018).

The provision of formal mathematics support initiatives has become more widespread within Irish HEIs in recent decades (Gill, 2010), with all HEIs offering one or more of dedicated drop-in mathematics support centres, preparatory mathematics programmes, and additional mathematics tuition through general support services (Ryan, 2013b). Dedicated mathematics support centres typically offer a drop-in service, with individual support to the student in aspects of mathematics that the student brings to the support setting, using appropriate resources and at a pace suited to the student’s level of understanding (Breen et al., 2015; Lawson et al., 2003). While many traditional students do not initially attend mathematics support centres, many mature students will avail of such help with mathematics from early in the academic term (Breen et al., 2015). The main motivations among mature students for attending mathematics support centres include the financial benefit of availing of a free support service; the motivation to
succeed by availing of additional help; gaining a deeper understanding of topics, particularly the use of symbols, and abstract concepts; and the importance of the one-to-one support in facilitating the student’s strategies with mathematics and their development as an independent learner (Breen et al., 2015; Miller-Reilly, 2006). In contrast, those students who did not attend claimed they did not need the support, and some had participated in a programme prior to starting at the HEI and had gained additional mathematics skills in that way (Breen et al., 2015).

Although it is difficult to ascertain that mathematics support alone is responsible for student retention and success in mathematics (Gill, 2010; Lawson et al., 2003), such initiatives make a largely positive impression on students’ competencies in mathematics (Fitzmaurice et al., 2015), with ongoing support impacting positively on – particularly mature students’ – self-efficacy in mathematics (Safford-Ramus, 2018), and subsequent ability to progress with mathematics and the programme of study (Johnson & O’Keeffe, 2016).

2.5.4 Test Anxiety

As referred to in section 2.1.1 mathematics anxiety can give rise to test anxiety (Hembree, 1990; Young et al., 2012), which in turn can impact negatively on performance, and repeated poor performance in situations of testing or evaluation can give rise to mathematics anxiety (Reyes, 1984; Zan et al., 2006). In addition, a student with high mathematics anxiety will frequently sacrifice accuracy for speed in testing situations in order to complete the test (Ashcraft & Krause, 2007). In this regard, the manner in which a student prepares for a mathematics test is significant, as well as their perceived importance of the test (Chinn, 2017; Turner et al., 2007). Students with higher levels of mathematics anxiety tend to resort to examination preparation techniques such as rote learning or choosing only to study those topics they feel more comfortable about (Chinn, 2017; Zaslavsky, 1994). The time limitation that accompanies situations of testing and evaluation can also inhibit performance leading to raised anxiety levels in respect of doing mathematics (Buxton, 1991).

Rather than attempting to remove anxiety completely in respect of a student’s approach to mathematics, considering the presence of some anxiety – particularly the impact of worry on cognitive processes – is conducive to motivation (Zeidner & Matthews, 2011), channelling the feeling of anxiety into a productive learning outcome can result in a
positive advancement of learning (DeBellis & Goldin, 2006; Findon & Johnston-Wilder, 2018). In addressing test anxiety, Zeidner (2007) advocates the use of interventions that would both reduce the test anxiety and associated emotional stress, as well as improve the classroom experience, and overall academic performance. These include providing students with ample information in advance of the examination; a task-oriented rather than competitive approach; a balance of easy and more challenging questions; allowing choice in the examination, as well as open book approach; allowing students a chance to comment on the examination during the examination; a reduction in time limitation and associated pressure; provision of reassurance and emotional support; and the provision of a ‘recovery room’ where very anxious students can take time out before continuing with the examination (Zeidner, 2007).

2.5.5 Additional Situational Challenges for Mature Students

Mature students who have had negative experiences of mathematics in school often find it difficult to move beyond those past experiences when faced with situations involving mathematics or when it comes to doing mathematics as adult students (Boaler, 2016). They may hold intense negative feelings around mathematics that stem from bad, or even traumatic experiences at school (Allen, 2016; Boaler, 2016). Where students have experienced limited success with mathematics (Hoffmann, 2010; Ma & Xu, 2004; Zeidner, 1991), they have approached mathematics based on how they have been previously affected by their engagement with mathematics (Geist, 2010, citing Donelle, Hoffman-Goetz, & Arocha, 2007; Gresham, 2009; Liu, 2008). The negativity is also compounded by societal attitudes towards mathematics – particularly in Britain and the USA – as a subject that is difficult, uninteresting, and inaccessible, beyond the reach of most people apart from the brightest individuals, being too difficult for girls, and viewed as being a nerdy, uncool subject (Boaler, 2016).

Mature students, who may not have had exposure to formal mathematics for a number of years, may feel at a considerable disadvantage compared with traditional students (Gill & O’Donoghue, 2006; Golding & O’Donoghue, 2005). Indeed, some mature students may not have done the Leaving Certificate examination or an equivalent, and in this respect being able to avail of dedicated preparatory or induction programmes for mature students (Fleming & McKee, 2005; Johnson & O’Keeffe, 2016) as well as support services like mathematics support centres is essential to ensure that mature students can adjust to the
demands of being in higher education (Fleming & McKee, 2005; Johnson & O’Keeffe, 2016). Research has shown that mature students frequent mathematics support facilities more often than their traditional counterparts (Breen et al., 2015; Faulkner et al., 2016; Gill & O’Donoghue, 2007), and that mature students who avail of these services perform better in their service mathematics modules than those who do not (Faulkner, Fitzmaurice & Hannigan, 2016; Johnson & O’Keeffe, 2016). In addition, for mature students whose first language is not English, there is a reliance on their native language to understand mathematics while learning the numerical concepts in academic English (Clarkson, 2009; Martiniello, 2008); where word problems are concerned the challenge for non-native English speakers is to understand both the meaning and context for the mathematical word problems, which as Woolley argues should be checked by the instructor to ensure the accuracy of the students’ understanding (Woolley, 2013).

A more in-depth look at issues pertaining to the mature student in Ireland will be presented in section 2.10. In the interim, the next section focuses on the approaches used to detect mathematics anxiety.

2.6 Detecting the Existence of Mathematics Anxiety

Early studies of mathematics anxiety involving college or university students used tests with measurement scales to assess the levels of mathematics anxiety among these cohorts. These tests evolved from existing tests for test anxiety, which were adapted to include components relevant to anxiety specifically about the students’ experiences of mathematics, for example the Taylor Anxiety Manifest Test (1953) adapted by Dreger and Aiken (1957) to assess number anxiety (Dreger & Aiken, 1957). Research by Suinn (1970, cited in Suinn, Edie, Nicoletti & Spinelli, 1972) into students availing of a counselling services programme in behaviour therapy found that over one third of these students cited mathematics as their main problem; this augmented the need for instruments to measure anxiety towards mathematics among higher education students (Suinn, Edie, Nicoletti & Spinelli, 1972). A popular test since its inception in 1972 has been the Mathematics Anxiety Rating Scale, or MARS (Suinn et al., 1972); it was initially used in programmes that would prepare adults to return to education (Richardson & Suinn, 1972). The compilation of the original 98-item scale incorporated statements pertaining to a variety of situations involving the use of mathematics or numbers, with the intended audience being broader than the college or university student population.
Respondents would indicate their level of anxiety towards each statement on a scale ranging from ‘not at all anxious’ – with a score of 1 – to ‘very much’ anxious – with a score of 5. Thus, a high score on the MARS test indicated a high-level of mathematics anxiety (Suinn et al., 1972).

High levels of validity and reliability gave the MARS test a place of prominence in the testing of mathematics anxiety among students and led to the revision of the original 98-item test to suit school-going children at primary level – MARS-E or MARS for Elementary School Students (Suinn et al., 1988) – and second level – MARS-A or MARS for Adolescents (Suinn & Edwards, 1982). The MARS itself was revised to a 30-item instrument – the MARS-30 – to address the administrative challenges of the test, since the 98-item scale took a considerable amount of time to complete (Suinn & Winston, 2003). An alternative, concise approach to the administration of the MARS family of tests has been suggested and tested (Ashcraft, 2002; Núñez-Peña, Guilera & Suárez-Pellicioni, 2014), namely the single-item mathematics anxiety (SIMA) scale (Núñez-Peña et al., 2014), which asks “On a scale from 1 to 10, how math anxious are you?” with 1 being ‘not anxious’ and 10 being ‘very anxious’. The particular appeal of the SIMA scale is the ease and speed of administration, especially among large groups of students, and use of this method has been tested among various disciplines at undergraduate level (Núñez-Peña et al., 2014; Foushee, Jansen & Srinivasan, 2016), and has shown strong support for validity and reliability of the scores achieved (Núñez-Peña et al., 2014). (A list of other tests for assessing mathematics anxiety is presented in Appendix C).

2.6.1 The Mathematics Anxiety Scale – UK

The Mathematics Anxiety Scale – U.K. (hereafter MAS-UK) evolved from Richardson and Suinn’s (1972) MARS instrument and subsequent versions of the MARS (Hunt et al., 2011), and like its predecessors, the MAS-UK involves a list of statements relating to situations involving mathematics (Hunt, 2011). The impetus to develop the MAS-UK was threefold; first, the need to develop an instrument to measure mathematics anxiety whereby the terminology was comprehensible to non-North American – particularly British and European – populations (Hunt et al., 2011: p. 126); second, the need to provide normative data on the extent of mathematics anxiety among a British population, with particular interest in the prevalence of mathematics anxiety in respect of gender and across subject disciplines (Hunt et al., 2011); and third, the development of a factorial
structure, with three sub-scales that “make intuitive sense” – Mathematics Evaluation Anxiety, Everyday/Social Mathematics Anxiety, and Mathematics Observation Anxiety (Hunt et al., 2011: p. 125). These findings contrast with those of Suinn and Winston (2003) who identified Math Test Anxiety and Numerical Anxiety as the two dimensions of mathematics anxiety within the MARS-30. More recent factor analysis of the MARS-30 by Wilder (2013) identified that while the Numerical Anxiety factor dominates the statements of the MARS-30, the highest scores stem from the Math Test Anxiety factor, indicating that the evaluation of mathematics contributes more frequently to the existence of mathematics anxiety (Wilder, 2013).

2.6.2 Suitability of Mathematics Anxiety Tests

Despite its prominence as a measure of mathematics anxiety, the development of the MARS – and its iterations – has stemmed from the discipline of psychology, and consequently has been criticised as not having its basis in the theory of mathematics education (McLeod, 1992; Zan et al., 2006). In her research into the findings of various MARS-based tests for mathematics anxiety among college students, and the factor analyses of these instruments, Wilder (2013) identified inconsistencies in that the dominant subscale – either Numerical Anxiety or Mathematics Test Anxiety – differed among the various tests administered. A lack of investigation into the scores of MARS-based tests has made it difficult to identify which subscale is prevalent (Wilder, 2013). In addition, there may have been differences in the participating samples themselves, such as the discipline of study of the student participants (Pletzer et al, 2016) or the fact that the participating cohort may not have been students but professionals and/or members of the general public (Pletzer et al., 2016); consequently, the use of the MARS-based instrument alone may be insufficient in determining mathematics anxiety (Wilder, 2013: p. 13). This reflects Bessant’s contention that “the complexity of mathematics anxiety cannot be limited to factors identified in the MARS” (Bessant, 1995: p. 327).

Both Henschel and Roick (2018) and Wilder (2013) question the validity of instruments such as the MARS being used to measure mathematics anxiety; Henschel and Roick (2018) contend that the emphasis in MARS tests is on the psychological rather than the cognitive dimension, with scores being reflective of the affective component. Further, they argue that the scores reflect mathematics anxiety as a unidimensional construct, thereby not reflecting the true complexity and factors of the construct (Henschel and
Roick, 2018). Wilder (2103) asserts that MARS results showing a lack of high scores – especially in the numerical anxiety subscale – were not reflective of anecdotal evidence as conveyed to college professionals. The comparison of levels of mathematics anxiety across subscale findings, while identified as important for the identification of trends among subscale factors, was deficient in the reporting of same in the literature (Wilder, 2013). Like Henschel and Roick (2018), Wilder (2013) also argues that the test may not incorporate all aspects of mathematics anxiety. In addition, the use of questionnaires as a self-report measure can pose problems (Dowker, Bennett & Smith, 2012) such as the question of accuracy and truthfulness in respect of the respondents’ answers (Dowker et al., 2016).

Alternative efforts to measure mathematics anxiety have included the use of physiological measures, such as measurement of physiological arousal (heart rate, skin fluctuations – Dew, Galassi & Galassi, 1984), and more recently brain activity using functional brain imaging technologies (Maloney, Ansari & Fugelsang, 2011; Lyons & Beilock, 2012; Maloney & Beilock, 2012; Nunez-Pena, Bono & Suarez-Pellicioni, 2015) which have been utilised to explore the impact of mathematics-related anxiety responses on mathematics performance (Lyons & Beilock, 2012). It is noteworthy that research of this nature has shown the effect of mathematics anxiety on the brain is similar to that of the effect of different forms of stress (Young et al, 2012; Allen, 2016).

Reservations about the use of quantitative measures of mathematics anxiety contend that the use of tests like MARS and MAS-UK do not reflect the complexity of Mathematics Anxiety, and do not adequately capture the extent of the impact of mathematics anxiety on the research participants (Ma & Kishor, 1997; Zan et al., 2006; Wilder, 2013). McLeod (1992) contends that the focus on quantitative methods falls short in supporting research into emotional responses to mathematics and mathematical problem solving, including the study of mathematics anxiety (McLeod, 1992). McLeod advocates a new paradigm for research on the affective domain in respect of mathematics, drawing on the disciplines of developmental psychology and cognitive psychology; the paradigm places emphasis on theoretical issues, and employs the use of qualitative methods to investigate responses on participants’ attitudes, beliefs, and emotions (McLeod, 1992; Bessant, 1995).
2.7 Talking About Negative Mathematics Experiences

Unpleasant experiences in mathematics frequently occur in the early years at school (Zaslavsky, 1994), experiences that can have a detrimental effect on the learner’s confidence in mathematics, resulting in subsequent development of mathematics anxiety (Zaslavsky, 1994). Failure in mathematics can be a distressing experience, accompanied by feelings of defeat, incompetence, and fear (Tobias, 1993; Arem, 2010). The moment a student learns they have failed, it can be a defining moment in terms of their subsequent engagement with the subject, sometimes with long lasting effects (Tobias, 1993). Such significant experiences can be responsible for students not wanting to engage with mathematics any further, despite reassurance from the teacher (Tobias, 1993). Having an opportunity to reflect on and talk about these unpleasant experiences with other people is viewed as therapeutic and supportive (Zaslavsky, 1994; Finlayson, 2014). In a related manner, bibliotherapy – where the student can read about the negative experiences of others with similar feelings towards mathematics (Furner, 2004) – as well as expressive writing are both conducive to the alleviation of mathematics anxiety (Maloney & Beilock, 2012). Affording students the opportunity to write freely about their emotions towards a pending event involving mathematics allows them to freely describe how they feel. Expressive writing helps the student to reflect on and re-evaluate previous negative experiences with mathematics to lessen the need to worry about mathematics (Finlayson, 2014). This activity is conducive to a positive outcome for those students in situations of mathematics testing (Maloney & Beilock, 2012). In addition, the use of metaphor is effective in helping students to describe their experiences with mathematics (Tobias, 1993; Coben & Thumpston, 1995). Tobias presents the following examples:

- curtain had been drawn, one they would never see behind;
- an impenetrable wall ahead;
- at the edge of a cliff, ready to fall off.

(Tobias, 1993: p. 51)

2.7.1 Mathematics Anxiety and Narrative

Efforts to obtain more of an understanding of mathematics anxiety have included the use of personal, one-to-one interviews (Miller & Mitchell, 1994). Affording the opportunity for individuals to talk about their experiences of mathematics, particularly negative experiences, provide researchers with significant accounts of experiences with mathematics that cannot be captured using quantitative methods (Miller & Mitchell, 1994; Stoehr, 2015) such as dedicated mathematics anxiety tests using Likert-type scales.
The use of personal narrative to study people’s experiences of mathematics has been represented in various guises; these are summarised in Table 2.1 and elaborated upon in the subsequent paragraphs.

**Table 2.1 Summary of approaches to elicit people’s stories about mathematics**

<table>
<thead>
<tr>
<th>Approach used</th>
<th>Researcher(s)</th>
</tr>
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<tbody>
<tr>
<td>Mathematics Life Histories</td>
<td>Tobias, 1993; Coben and Thumpston 1994-6</td>
</tr>
<tr>
<td>Automathematics biographies</td>
<td>Briggs, 1994</td>
</tr>
<tr>
<td>Mathematical Autobiography</td>
<td>Bloomfield and Clews, 1995</td>
</tr>
<tr>
<td>Math Life Stories</td>
<td>Drake, 2006; Stoehr, 2015</td>
</tr>
</tbody>
</table>

### 2.7.2 Mathematics Life Histories / Mathematics Autobiographies

Early attempts to capture mathematics autobiographies stem from work by Tobias and Donady to help the student identify the source of the problem. The aim was to alleviate the symptoms of mathematics anxiety – not by apportioning blame – but through an understanding of significant events in the mathematics student’s life, either orally or in writing (Tobias, 1993). Efforts to treat mathematics anxiety among adult students initially favoured the interview setting as an approach to diagnose and help facilitate treatment of mathematics anxiety (Tobias, 1993; Elam & Cook, 2005). It involved a one-to-one interview situation facilitated by the mathematics clinic (Tobias, 1993), with a counsellor questioning the adult student about their past experiences with mathematics; this contributes to the formation of an overall picture of the student’s story – their mathematics autobiography (Elam & Cook, 2005). Identification of the fears and phobias around mathematics can be the starting point to enabling the student to approach mathematics in a more positive and productive way (Buxton, 1991; Elam & Cook, 2005; Kogelman & Warren, 1978; Tobias, 1993).

Figure 2.2 shows sample questions used by Tobias and colleagues to elicit the mathematics autobiography of the student (Tobias, 1993).
How well do you think you understand arithmetic, algebra, and geometry now?
What feelings have you been harbouring about mathematics?
What kind of schooling did you have?
Who helped – at home?
Do you remember what people said to you when you made a mistake in math or when you did unexpectedly well?
When did failure begin?
Do you feel that you don’t know how to read a math textbook?
Do you fear that you are slow?
When you solve a problem, do you know why?
Do you think that you have been away from math for so long that you have forgotten everything?

**Figure 2.2 Questions to Elicit Mathematics Autobiography**
(sourced from Tobias, 1993: p. 242)

Influenced by the work of Tobias (1978), Briggs (1994) presented the concept of an ‘automathematicsbiography’ which she describes as “an autobiography of writers’ experiences of mathematics, from earliest memories to present day” (Briggs, 1994: 24), with the intention of using these autobiographies to explore impressions (usually relating to specific mathematics topics like algebra, or fractions), feelings (both positive and negative), and ideas (gender differences, and influence of others) about mathematics that have a bearing on the research participants’ reactions to mathematics. The experience is significant in eliciting strong negative feelings about mathematics (Briggs, 1994).

Bloomfield and Clews (1995) used ‘mathematical autobiography’ to identify categories of student experiences, resulting in:

- ‘influences’ (those factors which are important to the student in forming their view of mathematics and their attitude to the subject),
- ‘critical points’ (moments of crisis or sudden change when positive or negative influences become more extreme),
- and ‘constraints’ (personal factors which override counter influences and critical points, [acting] as a barrier to success or failure’).

(Bloomfield & Clews, 1995: p. 34)

Coben and Thumpston (1995) used the expression ‘mathematics life histories’ to explain adult students’ own experiences of mathematics throughout their lives (cited in Coben, 2000: p. 53). Their research involved the use of mathematics life histories to elicit accounts of the meaning of mathematics in the lives of adult students studying for a degree (Coben, 2000). Using semi-structured interviews to enable ‘points of comparison’ (Coben, 2000: p. 54) among the participants, the accounts presented four themes, which the authors referred to as:
‘the brick wall’ – the point (usually in childhood) at which mathematics ceased to make sense;

‘the significant other’ – someone perceived by the interviewee as a major influence on his or her mathematics life history;

‘the door’ – marked ‘Mathematics’, locked or unlocked, through which one has to go to enter or progress within a chosen line of work or study;

‘invisible mathematics’ – the mathematics one can do, which one does not think of as mathematics – also known as common sense.

(Coben, 2000: pps. 54-55)

Elam and Cook (2005) advocate the significance of interviews in eliciting the mathematics autobiography. The act of talking about one’s experiences during the interview is therapeutic (Tobias, 1993) in that the process helps the student to recall their early attitudes to mathematics and to recognise that their current feelings and reactions towards mathematics can stem from their past experiences of mathematics (Elam & Cook, 2005).

Drake (2006) used mathematics story interviews to elicit turning point stories, where teachers’ early descriptions of mathematics are contrasted with their current perceptions of their approach to mathematics as teachers and learners. This methodology was based on McAdams (1993) life story interview protocol to acquire the mathematics story at that point in time; the focus was on nuclear episodes (McAdams, 1993), namely high points (associated with positive emotions), low points (associated with negative emotions) and turning points (events conducive to considerable change in their engagement with mathematics) in the participants’ experiences with mathematics (Drake, 2006).

More recently, McCulloch and colleagues (2013) asserted the popularity of mathematics autobiographies – particularly oral accounts – in research into primary school teachers’ – specifically K-2 teachers’ – attitudes, beliefs, and identities in respect of mathematics (McCulloch et al., 2013: p. 381); and Stoehr (2015) used mathematics autobiographies, with a focus on the story presented and a reflection on the narrator’s experiences.

The use of stories to convey one’s experiences with mathematics has allowed these life events to be contextualised in the research participants’ own voices, and their approach to mathematics as a subject to be understood (Drake, 2006). The examination of one’s life experiences with mathematics is identified as beneficial in distinguishing particularly negative episodes with mathematics, or even what may be considered the source of an individual’s problem with mathematics (Tobias, 1993).
2.8 Addressing Mathematics Anxiety

A dislike of mathematics can stem from an uncertainty about the purpose of mathematics, which can be enhanced in the school environment and mathematics curriculum (Chinn, 2017; Zaslavsky, 1994). The prevalence of negative attitudes towards mathematics within the school environment or outside can contribute to the development of mathematics anxiety (Maloney & Beilock, 2012). Many students with mathematics anxiety learn to cope by developing strategies to address their levels of mathematics anxiety (Cemen, 1987; Miller-Reilly, 2006). These can include availing of supports external to the formal classroom environment – including peer support (Boston, 2017; Kyle & Kahn, 2009), private tuition (Breen et al., 2015), or attending a dedicated mathematics support centre (Lawson et al., 2003) – or avoidance strategies in mathematics (Turner et al., 2002). Consequently, control of such attitudes may facilitate improvement in mathematics for those mathematics anxious students (Maloney & Beilock, 2012). In this regard, the role of the teacher is significant in contributing to the presence – or not – of mathematics anxiety among students, both in the way the teacher conveys their own attitudes towards mathematics, and in the ways they support students with anxiety towards mathematics (Metie, Frank & Croft, 2007).

Measures to counteract mathematics anxiety have been manifold; these include dedicated mathematics modules or short courses (Arem, 2010; Gill, 2010; Harper & Daane, 1998; Sloan, 2010), variations in teaching methodologies (Connor, 2008), the use of ICT to facilitate mathematics learning (Furner & Duffy, 2002; Sun & Pyzdrowski, 2009), bibliotherapy (Furner, 2004), writing about one’s fears in respect of mathematics prior to an examination (O’Sullivan et al., 2017), keeping reflective diaries (Maloney & Beilock, 2012), one-to-one tuition through mathematics support facilities at higher education institutions (Fitzmaurice et al., 2015), cognitive behavioural therapy (Karimi & Venkatesan, 2009), and more recently virtual reality interventions (Davis & Khan, 2018).

Within higher education the availability of support mechanisms for students is significant in helping students deal with and overcome their anxiety towards mathematics (Betz, 1978; Fitzmaurice et al., 2015; Zaslavsky, 1994). However, while many of these measures serve as treatment for existing mathematics anxiety, prevention of the onset of mathematics anxiety requires identifying and addressing those antecedents of mathematics anxiety relevant to each mathematics anxious student (Arem, 2010;
Maloney & Beilock, 2012). In this regard, exploring the past experiences of mature students with mathematics can facilitate an important insight into how they have experienced mathematics with a view to understanding the possible causes of their levels of anxiety towards mathematics. This also necessitates understanding of the mature student and their reasons for engaging with higher education. To this end, the next sections of the chapter look at the backdrop to facilitating mature student enrolment in higher education in Ireland and examine the profile of the mature student in Ireland today.

2.9 Widening Access to Higher Education in Ireland


The White Paper defines adult education as “systematic learning undertaken by adults who return to learning having concluded initial education or training” (DES, 2000: p. 12), and uses the term ‘mature student’ to denote the adult learner in higher education. To encourage mature entrants to enrol in higher education programmes, a number of incentives were put in place subsequent to the release of The White Paper; these included the realisation of dedicated institutional support facilities for mature students (DES, 2000), assistance with programme fees and maintenance, student grants for full-time applicants, tax relief, and support for persons with disabilities (Citizens Information,
2013). However, despite the intentions of the government to widen access to higher education, criticism of The White Paper has pointed to the need to devote efforts into a dedicated focus on widening access for mature students as a distinct group (HEA, 2004). The trend in mature student enrolments which had seen an increase since 2008, levelled off in 2012 and 2013 (DES, 2015; HEA, 2014a) and has been in decline up to 2018 (HEA, 2018). By January 1st 2018 some 4005 mature students were enrolled as new entrants at either Uni or IoT level in Ireland, with 61% of these attending Institutes of Technology (HEA, 2018). This represents a drop of 30% in the numbers of mature students enrolling in higher education since January 2013 (HEA, 2018), and reflects a considerable disparity from the intentions of the White Paper (2000) and subsequent revisions of enrolment targets during this period.

More recently, a further initiative to promote access has been the latest iteration of the National Access Plan (NAP) for Equity of Access to Higher Education (2015 – 2019) which targets less well represented groups in higher education, including first time mature student entrants, with the intention of increasing participation rates (DES, 2015); however, a review in December 2018 of the progress of the NAP for Equity of Access to Higher Education (2015 – 2019) has indicated that targets for mature student enrolment are not being met, due in part to the unforeseen economic upturn and progress toward full-employment in Ireland (HEA, 2018). In spite of this, the target for first-time mature student enrolment by 2021 is to be retained at 16% for full-time entrants, and 24% for combined full-time and part-time admissions (HEA, 2018).

2.9.1 Barriers to Entering Higher Education

The prospect of entering higher education – while attractive to those students who wish to enhance their employment potential (DES, 2015) – is not an option for many adults as barriers to participation exist, including geographic, demographic and socioeconomic factors (Cilasun, Demir-Seker, Dincer & Tekin-Koru, 2018), the inaccessibility of information about programmes (McCoy & Byrne, 2011), the lack of guidance in respect of choosing the right course to suit their circumstances (Safford-Ramus, 2018), and psychological barriers including self-esteem issues (Cilasun et al., 2018; Safford-Ramus, 2008). Consequently, the decision to return to education typically represents a new phase or turning point in the life of the adult learner (Osborne, Marks & Turner, 2004; Pritchard & Roberts, 2006); they may have had to overcome obstacles that previously prevented
them from engaging with higher education, such as financial constraints, shortage of time to commit to education, or poor experience of education in their past; they may have had limited opportunities to do the course they wanted to pursue, or they may not have known when they left school which career path to take (Pritchard & Roberts, 2006).

2.9.2 Adult Education and the Adult Learner

Adults can be experientially rich learners with effective powers of deduction and abstraction, have preferred paths of perceiving, judging, remembering and problem solving and will often take a deep approach to learning (Kelly, 2006; Knowles Holton & Swanson, 2005; Rogers, 1996; Wlodkowski, 1999). The study of adult learning – andragogy – has emerged and expanded due to the perceived inadequacies of pedagogical approaches to facilitate adult learning (Ekoto & Gaikwad, 2015). Malcolm Knowles is credited with popularising the theory of andragogy to highlight the fact that adults and children learn differently (Knowles et al., 2005). While Knowles’s conceptualisation of andragogy – mainly in respect of his assertions about its distinction from pedagogy – was met with both praise and criticism (Tight, 2002), it provided a framework for discussion on the topic of adult learning, with centrality given to the learner’s prior experiences, interests, and motivations (Ekoto & Gaikwad, 2015). During the late 20th century Knowles, Holton and Swanson (1998) presented the revised andragogical model, designed to focus on the education of adults, and comprising six core principles:

1. Adults need to know why they need to learn something;
2. Adults maintain the concept of responsibility for their own decisions, their own lives;
3. Adults enter the educational activity with a greater volume and more varied experiences than do children;
4. Adults have a readiness to learn those things that they need to know in order to cope effectively with real-life situations;
5. Adults are life-centred in their orientation to learning;
6. Adults are more responsive to internal motivators than external motivators.

(Knowles et al., 2005: p. 72)

Knowles and colleagues (2005) acknowledge that the varying circumstances of adult learners – namely, the individual learner, situational differences, and the goals and purposes of learning – can impact ‘more or less’ on the above principles (p. 3). In this regard, Knowles and colleagues recognise that adult learners comprise a cohort with very varied profiles (Alsop, Gonzalez-Armal & Kilkey, 2008; O’Donnell & Tobell, 2007), encompassing a diversity of roles and responsibilities (Burton, Lloyd & Griffiths, 2011). Research shows that adult learners tend to be highly motivated and have high completion
rates (Boon, (1980), Brookfield, (1986), Woodbyrne and Young, (1998), and Brady, (2001) in Kelly, 2006); where non-completion is the outcome for the adult learner, it is usually due to personal or financial issues rather than academic failure (Lucas & Ward, 1995 cited in Kelly, 2006). The positive contribution made by mature students to a programme of study is widely acknowledged, particularly where they have employment experience that they can relate to their programme of study and share with their peers (Brady, 1997; HEA, 2011; Kelly, 2006). However, despite these factors the desired number of mature students is not being reached in HE in Ireland, thereby not addressing the intentions of The White Paper and subsequent policy iterations in respect of widening access. An investigation into the profile of the mature student is warranted to help elucidate their key characteristics with a view to understanding their needs as they engage with HE programmes of study.

2.10 Profile of the Mature Student

The decision to enter higher education as a mature student can be influenced by many factors that may not be considered decisive issues for traditional-entry students, including the lack of recent experience of formal education, poor past experiences with education, the need to travel from home to the HEI, and family commitments with dependents (Burton et al., 2011; Kelly, 2006; O'Donnell & Tobbell, 2007; Ryan, 2013a). In 1997, Lynch collated findings from four datasets to create a profile of mature students in higher education in Ireland for the academic year 1993/94 attending undergraduate programmes at Universities, Institute of Technology colleges (Dublin area), and Regional Technical Colleges (RTCs); the following list presents a summary of the findings:

- 52% of new entrant mature students were aged between 23 and 30 years, and 15% were over 40 years;
- 81% of mature students at that time attended one of these HEIs, with the remaining 19% attending colleges of education or private colleges;
- 75% of mature students attended part-time and mainly outside of the university sector;
- 57% of part time new entrant mature students were male, with full-time mature student gender breakdown reflecting parity;
- Mature students comprised 85% of all part-time entrants and only 5.4% of full-time entrants.

(Lynch, 1997)
Using data sourced from the Higher Education Authority statistical records (HEA, 2016b; HEA 2017a), the following section looks at characteristics\(^1\) that typify the mature student in the Irish context for the academic year 2015/16.\(^2\)

2.10.1 Age\(^3\) and Gender

The single common factor among all mature students in Ireland is that they must be at least 23 years of age on January 1st in the calendar year of enrolment. The range of ages among the mature student cohort in Ireland, however, is extensive, with 54.6\% of all new entrant mature students being under 30 years of age. HEA figures for the category ‘30 and over’, while comprising a substantial number of students (45.4\%), has no further breakdown. Enrolment figures for mature students at IoTs and universities are presented in Figure 2.3. It is noteworthy that the percentages in each category are similar across sectors, with the largest proportion in each case aged 30 and over, and more than three-quarters aged 25 and above (HEA, 2017a).

![Figure 2.3 Mature Student Enrolments by HEI and Age Group in the Academic Year 2015/16 (adapted from HEA, 2017a)](image)

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1 In order to provide an insight into the profile of the mature student from the perspective of widening access (DES, 2000), the author has focused on the characteristics of Age, Sector and Level of Study, Financial Implications, Ethnic Diversity and Declared Disability, and Socio-Economic group.

2 The year 2015/16 was chosen as it coincides with the academic year in which data collection for the study occurred.

3 While the mature student is defined in terms of the age of the student at the time of enrolment onto the programme of study, certain data sources – CSO.ie, HEA.ie and OECD.org – categorise adults in Irish society in groupings (i.e. 20-24, 25-29, etc.) which make it difficult to decipher exact figures pertaining to the age of 23 years and above. Consequently, for the presentation of certain findings, the author has utilised data relating to persons aged 25 years and above, which concurs with the OECD description of the adult student as having completed upper-secondary education (OECD, 2013); consequently, where indicated, some findings represent an approximation of the actual figures.
More male than female mature students enrolled as new entrants in 2015/16. The gender breakdown of full-time new entrant mature students comprised 53% male and 47% female; there was a bigger gap between part-time male (57%) and female (43%) new entrants. Figure 2.4 shows the gender breakdown by HEI sector and mode of entry. While these figures show a relatively similar proportion of male to female mature entrants enrolling in the university sector, considerably more male than female mature entrants enrolled across the IoT sector.

![Figure 2.4 Gender of Mature New Entrants by Sector and Mode of Entry](sourced HEA, 2016a: p. 28)

**2.10.2 Sector, Mode and Level of Study**

Figures by the Higher Education Authority on new entrants to undergraduate programmes for 2015/16 show that 13.1% of all new entrants to higher education programmes were mature students, with more than twice as many mature students enrolling in Institutes of Technology (18.5%) compared with universities (8.7%; HEA, 2016a). These statistics can be broken down to reflect enrolment into full-time and part-time programmes: 10% of new full-time undergraduates and 85% of part-time undergraduates are mature students, advocating the appeal of the part-time mode of study to mature students (Ryan, 2013b); however, this shows a declining trend since the academic year 2010/2011, where the figures were 15% and 92% respectively (HEA, 2016a). Further, almost 18% of full-time mature students are international students, who have moved to Ireland for the purpose of studying (OECD, 2013); the highest proportions of full-time international students come from the European Union (39.5%), Asia (25.4%), and North America (14%) (OECD, 2013).
In the 5-year period since the academic year 2010/2011 there have been considerable differences between the proportions of new entrant mature students (both FT and PT) studying at undergraduate level (Table 2.2). There is an evident decline in level 7 – Ordinary Bachelor’s Degree/Diploma – enrolments in both sectors, as well as an increase in level 6 programmes – Higher or Advanced Certificate – in both sectors, particularly in the Institutes of Technology. In contrast are the figures for level 8 programmes – Honours Bachelor’s Degree/Higher Diploma – with a decrease at the university sector and an increase in the IOT sector.

### Table 2.2 Percentage of New Entrant Mature Students by Sector and Level of Programme of Study

(Source: HEA.ie, 2014a, 2016b)

<table>
<thead>
<tr>
<th></th>
<th>Mature Students as % New Entrants</th>
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</thead>
<tbody>
<tr>
<td><strong>Universities</strong></td>
<td></td>
</tr>
<tr>
<td>Level 6</td>
<td>92%</td>
</tr>
<tr>
<td>Level 7</td>
<td>81%</td>
</tr>
<tr>
<td>Level 8</td>
<td>11%</td>
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<tr>
<td><strong>Institutes of Technology</strong></td>
<td></td>
</tr>
<tr>
<td>Level 6</td>
<td>25%</td>
</tr>
<tr>
<td>Level 7</td>
<td>21%</td>
</tr>
<tr>
<td>Level 8</td>
<td>12%</td>
</tr>
</tbody>
</table>

### 2.10.3 Discipline of Study

Analysis of the discipline choice shows a variety of preferences among mature students in both sectors and for both full- and part-time modes of study (Figures 2.5(a) and 2.5(b)). Among full-time enrolments the discipline of Agriculture, Fisheries, Forestry and Veterinary has the highest proportion of mature student new entrants in the University sector (37%). Among both full-time and part-time programmes there is pronounced enrolment in Social Science, Business and Law programmes. Among part-time IoT enrolments Science Mathematics and Computing (34%) and Social Science, Business and Law (28%) are the most popular choices among mature students. In contrast part-time Uni enrolments among mature students are highest for Social Science, Business and Law (34%) and Health and Welfare (23%) programmes.
In the IoTs the spread is more uniform for full-time mature student enrolments, with more mature students opting to study within the IoT rather than the Uni sector for Science Mathematics and Computing (20% compared with 11%), Humanities and Arts (14% compared with 8%), Engineering, Manufacturing and Construction (14% compared with 3%), and Services (14% compared with 0%) (HEA, 2016b).

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4 Each category listed in Figures 2.5(a) and 2.5(b) is an overarching title to encompass a range of programmes, for example, Social Science, Business and Law comprises 18 different sub-categories of programmes of study. (HEA, 2016b). The categories General and Combined were omitted due to comparable proportion sizes rounding to 0%.
2.10.4 Travel to the HEI

Mature students tend to prefer to study close to home, particularly when they have family or caring commitments (Pritchard & Roberts, 2006), travelling shorter distances on average to the HEI (47kms) compared with traditional students (65kms) (HEA, 2016b). This however, impacts often negatively on the scale of choice of third level programmes at their disposal, particularly where desired programmes may not be readily available in an online or distance-learning format (Trant, 2013). The need to commute to the HEI necessitates that mature students typically do not get to participate in social activities on campus compared with traditional students, who often live near or on-campus. The time pressure on mature students means they do not have the liberty of waiting around perhaps to meet a lecturer at the end of the day to discuss issues with coursework (Thomas & Quinn, 2007).

2.10.5 Financial Implications

Financial difficulties are a major contributor of mature student dropout from higher education (HEA, 2014b; Thomas & Quinn, 2007) and can be more pronounced for mature students especially those with dependents (Lynch, 1997); indeed, where mature students do not complete a programme of study, it can sometimes be attributed to financial issues rather than failure in examinations (Kelly, 2006; Thomas & Quinn, 2007). The costs associated with returning to higher education can be a deterrent for prospective mature students, especially where costs are not subsidized, for example with fees for part-time applicants (HEA, 2014b; Walters, 1997). While a number of financial incentives\(^5\) exist for mature students who meet certain criteria, in 2015/6 29% of respondents to the Equal Access survey identified with serious financial difficulties (HEA, 2016a).

2.10.6 Ethnic Diversity and Declared Disability

The Equal Access survey of new entrants to higher education (HEA, 2016a) provides an insight into the respondents’ ethnicity and the prevalence of disability among full-time mature students. Respondents identifying their ethnicity as ‘Irish’ comprise the majority (78%), followed by ‘Any Other White Background’ (12.4%) and ‘African’ (4.8%); ‘Irish

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\(^5\) These include Back to Education Allowance (BTEA), Student Maintenance Grant, Student Assistance fund.
Traveller’ (0.1%) is the least represented ethnic group among mature students. While 7.8% of mature new entrants indicated having a disability, the types of disability reported are diverse, with the largest proportion declaring ‘Psychological/ Emotional Condition’ (43.1%), followed by a ‘Specific Learning Difficulty’ (38.2%), ‘Other including Chronic Illness’ (27.6%), and ‘Physical Condition’ (20.0%) (HEA, 2016b).

### 2.10.7 Socio-Economic Group

The Bologna Process since 1999 has advocated the inclusion of under-represented socio-economic groups within higher education (OECD, 2013). When compared with the 2011 census figures for the population (Figure 2.6), the representation of each socio-economic group among full-time mature students varies considerably. There is pronounced under-representation of mature students from the ‘non-manual’ and ‘lower professional’ groups; while the ‘manual skilled’, ‘unskilled’ and ‘own account workers’ groups are highly represented among full-time mature new entrants.

![Figure 2.6 Percentage of Full-time Mature Student New Entrants compared with Percentage of National Population in each Socio-economic Group](source: compiled by author using data from HEA, 2016b and CAO, 2016)

The representation is expanded further in Figure 2.7, with notable difference in the representation of the various groups within the two sectors.

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6 The CSO category ‘Z. All others gainfully employed and unknown’ has been omitted here, as corresponding data had been omitted in the HEA data source (HEA, 2014a).
Mature students from the ‘non-manual’, ‘manual skilled’, semi-skilled’, and ‘unskilled’ groups feature more within the IoT sector than the university sector (59% compared with 42.5%). In contrast, most of the remaining categories have higher representation in the university sector, with parity for agricultural workers.

2.10.8 Summary

In consideration of the factors explored above, contemporary mature students are a heterogeneous cohort that comprise a diversity of ages, spanning a variety of programmes across university and IoT sectors, hailing from diverse socio-economic backgrounds, with a mix of issues shaped by their various life courses. In just over two decades – since Lynch presented her profile of mature students in higher education – there has been a considerable increase in the number of full-time mature new entrants, from 5.4% to 10%, while the number of part-time mature new entrants having experienced fluctuations is at the same level (85%). There has been a slight increase in the percentage of mature students aged under 30 years, from 52% to 54%. A new system of socio-economic categorisation adopted in 1996 (CSO, 2012) meant that a comparison of such profiles cannot be transparent; however, while the largest percentage of mature students in Lynch’s study were likely to represent the non-manual, followed by lower professionals and employers/managers group, the figures for 2015/16 showed that full-time mature

Figure 2.7 Participation of Mature Student New Entrants by Socio-economic Group and Sector
(Source: compiled by author using data from HEA, 2016b and CAO, 2016)
students were likely to come from manual skilled, followed by employers and managers, and non-manual backgrounds, showing a disparity in trends within two decades, and an under-representation among some lower socio-economic categories. There was no data in Lynch’s study pertaining to the level or discipline of programme studied by the mature students. It is also noteworthy that in the 2015/16 data set the findings showed that almost one fifth of all new entrant mature students are from overseas, while reference was not made to this demographic in the 1993/4 data.

Mature students’ successful engagement within undergraduate education may pose significant challenges, particularly as the higher education system facilitates an approach to teaching and learning which represents a logical follow-on for traditional students (Kelly, 2006). Mature students value positive contact with the HEI from the outset – for example, being able to telephone the HEI, or have their questions addressed at an information day/evening –, as well as being made aware of ongoing support systems to counteract the possibility of attrition (Kaldi and Griffiths, 2013). The factors that influence the mature student’s decision to pursue and continue with a programme of study are sensitive to minor changes to the extent that the decision to engage with their course of study could be negatively impacted upon (Osborne et al. 2004). Mature students tend to prefer to study close to home, particularly when they have family or caring commitments (Pritchard & Roberts, 2006). This however, impacts often negatively on the scale of choice of higher education programmes at their disposal, particularly where desired programmes may not be readily available in an alternative format, such as online or distance-learning (Trant, 2013).

There may exist a mismatch between the perception of the mature student in relation to the barriers they face and the perception of the institution of how these barriers actually affect the mature student (Burton et al., 2011; Thomas & Quinn, 2007). Individually, mature students possess specific needs in relation to their intentions for entering undergraduate studies at a HEI, and their ability to cope with this transition relies on the availability and effectiveness of supports for the individual (Ryan, 2013b).
2.11 Perception of Mathematics in Society

Negative discourse surrounds mathematics both as an academic subject and in its practical application on a day-to-day basis, and for people with mathematics anxiety their talk of mathematics comprises expressions of fear, apprehension, and tension in respect of doing or contemplating doing mathematics (Ashcraft, 2002; Beilock & Willingham, 2014; Richardson & Suinn, 1972). Mathematics anxiety is an international problem (Allen, 2016; Boaler, 2016; Beilock & Willingham, 2014) and affects students at all levels of education, as well as individuals who have to engage with mathematics or numbers in everyday or work contexts. Considerable media attention is given to news of poor performance in mathematics and numeracy with the publication of State Examination results, PISA and Trends in International Mathematics and Science Study (hereafter TIMSS) results, and more recently Programme for the International Assessment of Adult Competencies (hereafter PIAAC) results which ranks the numeracy competency of Irish adults below the International average (CSO, 2013; Ryan, 2014). The need to address such negativity at national level has been met with a number of initiatives at government level, including the revision of the mathematics curriculum at primary level in 2002, as well as at second level with revision of mathematics curriculum for the Junior Cycle in 2003 (Oldham, 2002) and the implementation of Project Maths for both Junior and Senior Cycles in 2010 (DES, 2008, 2010); the formulation and implementation of the Literacy and Numeracy Learning for Life Strategy (hereafter LNLL strategy) in 2011; the recent launch of the national Science, Technology, Engineering and Mathematics (hereafter STEM) policy (DES, 2017); and the Postgraduate Diploma in Mathematics for Teachers to address the professional development needs of out-of-field mathematics teachers (DES, 2011).

Ireland’s drive to become a knowledge economy has been used as a justification for the implementation of the LNLL Strategy (DES, 2011) and the recent launch of the STEM policy (DES, 2017). Consequently, the impetus for these policies is viewed as urgent national priorities for our education system (DES, 2011), as well as the aspiration of making Ireland an innovation leader at the forefront of technological and scientific change (DES, 2016). Competency in mathematics is perceived as an indicator of a student’s self-worth (Boaler, 2016), and the gatekeeper subject to many life opportunities, including education and career progression (Noyes, 2007), and whereby students can be filtered out of career paths that they might otherwise follow (Miller-Reilly, 2006). Thus, the
attainment of proficiency in mathematics, underpinned by the measurement of the extent of achievement of these skills, is desirable for the future success (Maloney et al., 2013) of the nation.

The ability to use mathematics in the workplace has become increasingly pervasive (Rawley, 2007; Tobias, 1993) and is more prevalently a requirement for new employees as well as in the upskilling of existing employees, broadening the socio-demographic profile of people using mathematics (Selden & Selden, 2001; Tobias, 1993). For existing employees, the need to engage with mathematics in a work context may ignite a desire to investigate their mathematics knowledge further in order to understand the work context better (Selden & Selden, 2001), or may instil fear and a reluctance to tackle mathematics (Rawley, 2007; Tobias, 1993). Hembree (1990) argues that the propensity for students to avoid mathematics is of national significance, as it considerably limits the options open to those students for career development and advancement in the areas of science and technology. Poor academic achievement in school is highly prevalent among low income families and minority groups, resulting in detrimental consequences for future employment and career prospects (Geist, 2010; Krowka, Hadd & Marx, 2017). Employees with high levels of mathematics anxiety can be detrimental to the effectiveness of the work environment; for example the inability of a nurse to correctly calculate drug dosages, or of a manager to engage in financial planning can lead to disastrous outcomes in their respective places of employment (Beilock & Willingham, 2014).

Beilock and Willingham (2014) contend that there is a belief within society that mathematics anxiety is a synonym for being bad at mathematics. This belief is problematic, particularly if this is the perception among policy makers, who may consequently be uninterested in giving attention to mathematics anxiety and its impact on students learning mathematics (Carey, Devine, Hill & Szűcs, 2017). Recent research by Pampaka, Eleftheriadou, Cascella, Estevez and Lei (2018) found that the consideration of mathematics anxiety as a concern is not prevalent among government policies around the world, although many policy documents reflect references to facilitating positive attitudes to mathematics (Pampaka, Eleftheriadou, Cascella, Estevez & Lei, 2018). In a society with an attitude of aversion toward mathematics (Vukovic et al., 2013b) and where the importance of mathematics is underrated, the learning environment for mathematics may be compromised (Ashcraft et al., 2007) through inadequate resourcing.
and poorly equipped teachers (Vukovic, Kieffer, Bailey & Harari, 2013a), resulting in a knock-on effect impacting on mathematics learning and students’ capability to do mathematics.

2.12 Conclusion

This chapter began with a review of the literature on mathematics anxiety, teasing out its various definitions and characteristics of the construct. The Model of a Mathematics Anxiety Reaction (Cemen, 1987) framed the structure of the literature review on mathematics anxiety and its antecedents, presenting relevant findings relating to the environmental, dispositional and situational antecedents of mathematics anxiety. The exploration of each of these three sets of antecedents has provided a comprehensive backdrop to facilitating an understanding of mathematics anxiety in order to inform the research design. Coupled with this, the second part of the chapter presented a review of the literature in respect of the positioning of the mature student within Irish undergraduate higher education. This was facilitated by exploring the distinctive characteristics of the mature student, which built on Lynch’s (1997) profile of mature students in higher education using comparisons of the statistical data.
Chapter 3 Research Design
3.0 Introduction

Central to choosing a research design is the identification that it is fit for purpose (Bold, 2012) and fulfils the research aim and questions (Creswell, 2009; Goodson & Sikes, 2001). In a social science context, the focus is on the human being and the construction of subjective meanings in respect of their social reality, the world they live in, meanings which differ from one person to the next, thereby contributing to the complexity of the data that can be obtained (Creswell, 2009; Thomas, 2009). In addition, the researcher brings their own interests, understanding, and knowledge of the world into the research context (Thomas, 2009) in order to explore those perspectives, shared meanings and insights into the research topic (Wellington, 2000: p. 16). The current study identifies with the philosophy of pragmatism. It has adopted a sequential mixed methods strategy of inquiry, specific research methods using quantitative and qualitative approaches to collect and analyse the data, as well as utilising these methods in tandem to strengthen the overall approach to interpreting the findings with the intention of addressing the research aim and questions (Creswell & Plano Clark, 2011). This chapter expands on each of these topics in respect of the current study.

3.1 Framework for the Research Design

The research design for the current study is prompted by Creswell’s (2009) framework for research design, comprising three parts: philosophical worldviews, strategies of inquiry, and research methods (see Figure 3.1).

![Figure 3.1 Framework for Research Design](adapted from Creswell, 2009: p. 5)
Collectively these comprise ‘the plan or proposal to conduct research’ (Creswell, 2009: p. 5), and are described in turn in the following sections.

3.1.1 Philosophical Worldview – Pragmatism

Creswell (2009) advocates the significance of expressing one’s worldview to provide a context for the researcher’s purpose in approaching the research project. A worldview is described as ‘a basic set of beliefs that guide action’ (Guba, 1990: p. 17, cited in Creswell, 2009: p. 6), or ‘a general orientation about the world and the nature of research that a researcher holds’ (Creswell, 2009: p. 6). The understanding of pragmatism as a philosophical worldview has been inspired by the work by John Dewey, George Herbert Mead, and William James, whose contribution is summed up by Morgan (2007, p. 67): “the essential emphasis is on actual behaviour (‘lines of action’), the beliefs that stand behind those behaviours (‘warranted assertions’), and the consequences that are likely to follow from different behaviours (‘workability’)”; thus the goal of the pragmatist’s work is to “search for useful points of connection” (Mertens, 2015: p. 36). A pragmatic worldview results from ‘actions, situations, and consequences rather than antecedent conditions’ (Creswell, 2009: p. 10), and, in this way, differs from the postpositivist perspective.

Early approaches to educational research were guided by the postpositivist – previously positivist – paradigm (Mertens, 2015), which underlies the use of scientific and quantitative methods (Kim, 2016; Tashakkori & Teddlie, 1998), such as experimentation and measurement, to investigate what can be observed (Mertens, 2015), with an emphasis on researcher objectivity and the generalisability of results (Crotty, 1998; Mertens, 2015). However, there are limitations to this epistemological approach with regard to understanding the complexity of the human situation (Kim, 2016); consequently, since the 1970s, the constructivist paradigm has gained prominence as a paradigm that facilitates investigation into the social construction of reality (Mertens, 2015). This paradigm shift has given rise to the use of qualitative methods (Guba & Lincoln, 1994) to facilitate the understanding and meaning of phenomena under study, with objectivity being replaced by confirmability (Kim, 2016; Lincoln, Lynham & Guba, 2013; Mertens, 2015).

The outcome of qualitative research is the pursuit of what Geertz (1973) called the ‘thick description’ (Cohen, Mannion & Morrisson, 2011; Jick, 1979; Johnson & Onwuegbuzie,
2004; Thomas, 2009), which focuses on the fuller, more substantial description (Sandelowski, 2000) in order to understand the meaning an individual attributes to an experience; in this regard, the context as well as the researcher’s ontological positioning and knowledge of the world are significant. By comparison, the outcomes of quantitative research methods are described as ‘confined’ or ‘skimpy’ (Sandelowski, 2000) or limiting (Becker, 1996) in terms of what can be discovered about the meanings research participants give to events, including researchers’ lack of consideration for unanticipated events. In contrast, qualitative researchers – due to the nature of their positioning ‘in the field’ – cannot ‘insulate themselves from the data’ (Becker, 1996: p. 56). This comparison presents qualities that can be positioned at either end of a continuum, and the middle of this continuum represents components of both quantitative and qualitative approaches, thereby characterising the positioning of the pragmatic paradigm (Tashakkori & Teddlie, 1998), constituted by the mixed methods approach to research (Creswell, 2009).

3.1.2 A Pragmatic Approach to Research

Pragmatism supports an openness to and versatility in the use of research methods, in that the researcher has flexibility with their choice of research methods, techniques and procedures that are appropriate and best suited to the researcher’s requirements for the research project at hand (Creswell, 2009; Mertens, 2015). Drawing on the work of Cherryholmes (1992) and Morgan (2007), Creswell (2009) presents a philosophical basis for the pragmatic approach to research:

- Inquirers draw liberally from both the quantitative and qualitative assumptions when they engage in their research;
- Researchers have a freedom of choice in respect of the choice of methods, techniques, and procedures of research that best meet their needs and purposes;
- Researchers look to many approaches for collecting and analysing data rather than subscribing to only one way;
- Researchers use both quantitative and qualitative data because they work to provide the best understanding of a research problem;
- Researchers need to justify why they need to mix their data;
- Mixed methods studies may include a postmodern turn, a theoretical lens that is reflective of social justice and political aims.

(adapted from Creswell, 2009: pp. 10-11)

The pragmatic approach to research is guided by the values of the researcher, resulting in a research study that is underpinned by ‘a practical and applied research philosophy [that] eschews the use of metaphysical concepts (Truth, Reality)’ (Tashakkori & Teddlie, 1998:
p. 30), and uses methods appropriate to what the researcher thinks is important in order to address the research questions (Cherryholmes, 1992; Tashakkori & Teddlie, 1998). The outcomes of the study are used “to bring about positive consequences” (Tashakkori & Teddlie, 1998: p. 30) that mirror the values of the researcher. As mentioned in chapter 1, the current study was prompted by the researcher’s need to address the apparent dislike of and negativity towards mathematics as expressed by her students, particularly mature students, and which prompted the research aim and questions.

3.1.3 Strategy of Inquiry – Sequential Mixed Methods Strategy

The mixed methods approach to research – also termed ‘mixed methodology or methodological mixes’ (Tashakkori & Teddlie, 1998: p. 5) –, underpinned by the philosophy of pragmatism (Creswell, 2009; Mertens, 2015), contends that the focus of research is on the “nature of the phenomena being investigated, [as well as] the contexts in which the study is conducted” (Mertens, 2015: p. 306). In addition, the value systems of the researcher are significant in providing the impetus for approaching the research topic, since the pragmatist will “study the topic in a way that is congruent with their value system, including units of analysis and variables that they feel are most likely to yield interesting responses” (Teddlie & Tashakkori, 2009: p. 90). Thus, the focus of the research is declared through the research problem, and knowledge about the problem develops through diverse approaches. This approach facilitates the generation of important research questions as well as requiring reasonable answers to those questions (Johnson, Onwuegbuzie & Turner, 2007).

Creamer (2017) presents four components that comprise the philosophy of mixed methods:

1. Qualitative and quantitative data and qualitative and quantitative methods are not incompatible;
2. There is added value by the combination of qualitative and quantitative approaches to produce more robust findings;
3. The assumption that the corroboration of multiple types of data or multiple data points (i.e. triangulation) enhances validity;
4. The use of a combination of methods can offset the weakness inherent in any method, known as the complementarity argument.

(Creamer, 2017: p. 5)

In the current study, the researcher acknowledges the use and benefit of both quantitative and qualitative methods in the study of mathematics anxiety to-date. However, the
researcher recognises that either the quantitative or the qualitative approach on its own is insufficient in depicting the specific aspects of circumstances and inclinations of individuals. Thus, the use of more than one method can help to illuminate the investigation into the research topic and provide a fuller picture of the subject matter (Tashakkori & Teddlie, 1998), thereby addressing the research questions (Mertens, 2015; Onwuegbuzie & Leech, 2006). In this regard, the current study adhered to a sequential explanatory mixed methods strategy of inquiry (Creswell & Plano Clark, 2011; Tashakkori & Teddlie, 1998) whereby, in a two-phase design (Creswell, 2009), the quantitative phase of the study informed the approach to the subsequent qualitative phase, and the two sets of findings were combined for analysis and interpretation purposes. The design approach for this study is depicted in Figure 3.2.
In designing a mixed methods study, Creswell and Plano Clark (2011) advocate four considerations in respect of the quantitative and qualitative strands; “whether the strands will remain independent or interactive; whether the two strands will have equal or unequal

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**Figure 3.2 Visual Model Depicting Sequential Explanatory Mixed Methods Design**
(adapted from Ivankova & Stick, 2007; Creswell & Plano Clark, 2011)
priority for addressing the study’s purpose; whether the strands will be implemented concurrently, sequentially, or across multiple phases; and how the strands are to be mixed” (Creswell & Plano Clark, 2011: p. 105). The design of this study allowed for an interactive approach, in that the findings and analysis of the quantitative phase informed the design of the qualitative phase, and the two sets of data were considered in the analysis and interpretation stages. Priority was unequal and favoured the qualitative phase, as the findings of the quantitative phase informed the purposive selection of candidates with varying levels of mathematics anxiety for interview; in the interview the focus was on the in-depth explanations of the mature students’ experiences of mathematics that give rise to their dislike – or otherwise – of mathematics. A sequential implementation of the strands was used, whereby quantitative was followed by qualitative. Finally, mixing occurred during the interpretation of findings.

The following section presents the research methods that have been used in this study.

3.2 Research Methods

The research methods of this study comprised two phases: phase one was quantitative and phase two was qualitative. Figure 3.3 presents a procedural visualisation (Creswell & Plano Clark, 2011) to facilitate understanding of how the mixed methods design for this study addressed the research questions. The visualisation depicts the separate paths taken to addressing RQ1 and RQ2, whereby each question has its corresponding data sources, information sourced through the data collection tool used (questionnaire and interview), as well as the understanding gained in respect of the results of each phase of data collection and analysis. Finally, the last column depicts the approach to the interpretation of findings in respect of addressing both RQ1 and RQ2. RQ1 is addressed through interpretation of the data analysis using descriptive statistics; RQ2 is addressed through the interpretation of results from the combination of findings from the quantitative and qualitative data. Each phase is explained in more detail in sections 3.2.1 (Phase One: Quantitative), 3.2.2 (Phase Two: Qualitative), and 3.3 (Analysis of Data).
<table>
<thead>
<tr>
<th>RESEARCH QUESTIONS</th>
<th>DATA SOURCES</th>
<th>INFORMATION SOURCED</th>
<th>UNDERSTANDING GAINED</th>
<th>INTERPRETATION OF FINDINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To what extent does mathematics anxiety exist among mature students studying service mathematics in Ireland?</td>
<td>• Survey N=107</td>
<td>• Gender, Age, Years out of school, Discipline of study; • Rating of Ability in Mathematics at different levels of education; • How anxious they feel about mathematics now; • MAS-UK Score; • Individual scores for each statement and factor.</td>
<td>• Levels of anxiety among this cohort; • Correlations with MA scores and age, discipline of study, etc. • What in particular causes most/least anxiety collectively among this group? (particular MAS-UK statements/factors)</td>
<td>To address RQ1: • Survey results (N=107) analysed using descriptive statistics. To address RQ2: • Analysis of 20 Participants’ MAS-UK scores and scores for the three MAS-UK factors (Mathematics Evaluation Anxiety, Everyday/Social Mathematics Anxiety, and Mathematics Observation Anxiety) • Analysis of 20 Participants’ Life Story interview findings structured by the adapted Life Story framework • Combination of quantitative results with QUALITATIVE findings using clusters of low, mid-range, and high levels of each factor of mathematics anxiety combined with participants’ responses framed by environmental, dispositional and situational incidents.</td>
</tr>
<tr>
<td>2. To what extent do specific incidents in a mature student’s mathematics life story give rise to the level of mathematics anxiety that the student experiences?</td>
<td>• Life Story Interview using adapted life story Framework 20 Participants</td>
<td>• Feelings about mathematics in general; Early memories of mathematics, including primary school; Mathematics at secondary school; Mathematics after school, including the work environment; Mathematics in current programme of study (including role of mathematics in decision to apply to third level); Significant others; Strategies to overcome stresses and problems with mathematics; Future script; Theme for overall mathematics life story.</td>
<td>• Feelings these students have generally about mathematics; • Incidents at primary school that have contributed to their level of MA; • Incidents at secondary school that have contributed to their level of MA; • Incidents after schooling that have contributed to their level of MA; • Incidents in higher education that have contributed to their level of MA; • How significant people have contributed to their level of MA; • Strategies these students have employed to get by in mathematics; • How these students see mathematics in their future lives/careers; • Theme for their relationship with mathematics.</td>
<td></td>
</tr>
</tbody>
</table>
3.2.1 Phase One: Quantitative

The study of historical episodes in a person’s life can be achieved using both quantitative and qualitative data sources. In a mixed methods study, quantitative methods can be used to provide data that give a general context for the topic of research (Mertens, 2015), whereby nominal data on respondents’ biographical details are combined with scales that gain data on attitudes, beliefs and experiences (Cohen et al., 2011), such as those facilitated by the Mathematics Anxiety Scale UK (hereafter MAS-UK). In this study, quantitative data were collected to address the first research question, and thereby set the context for the subsequent qualitative phase and focus on research question two. The quantitative data were collected by means of an online survey, using the website Survey Monkey (www.surveymonkey.com). A survey is the process of gathering data “at a particular point in time with the intention of describing the nature of existing conditions or identifying standards against which existing conditions can be compared or determining the relationships that exist between specific events” (Cohen et al., 2011: p. 256).

3.2.1.1 Online Questionnaire

The purpose of the survey in this research project was to address the first research question, i.e. to what extent does mathematics anxiety exist among mature students studying service mathematics in Ireland, by providing an insight into the use of the MAS-UK as an instrument that is used to determine the level of mathematics anxiety among students. The survey data was collected using an online questionnaire. The questionnaire had a highly structured format, with a majority of closed questions, to enable faster and more straight-forward analysis of the answers (Cohen et al., 2011). This in turn necessitated that the questionnaire had to be tested and refined through a piloting process, in order to ensure the wording of the questions and variety of responses available to those responding were comprehensible and appropriate (Cohen et al., 2011). Before using Survey Monkey, it was necessary to plan the questionnaire; Cohen, Manion and Morrison (2011) present an eight-step sequence for questionnaire planning:

1. Decide the purpose for the questionnaire.
2. Decide the population and the sample.
3. Generate the topics to be addressed and the data required in order to meet the objectives of the research (i.e. using the literature review, or a pre-pilot).
4. Decide the kinds of measures/scales/questions/responses required.
5. Write the questionnaire items.
6. Check that each issue from (3.) has been addressed, using several items for each issue.
7. Pilot the questionnaire and refine items as a consequence.
8. Administer the final questionnaire.

(adapted from Cohen et al., 2011: p. 379)

These eight steps were applied to the planning of the questionnaire for this study as follows:

1. Decide the purpose for the questionnaire. The purpose of the questionnaire was to gather data that would to some extent address the first research question. In order to make each potential participant aware of the purpose, a paragraph describing the context for the study was included at the beginning of the information sheet (Appendix D) that was distributed to students by myself at induction or distributed on my behalf by the mature student officer/access officer at the HEI via email attachment; this paragraph was also present at the beginning of the questionnaire (Appendix E).

2. Decide the population and the sample. The target population was mature students attending higher education in Ireland who had a service mathematics component as part of their programme of study. In choosing the sample, Cohen and colleagues (2011) advise giving attention to five criteria: the sample size; the sampling strategy to be used; the representativeness and parameters of the sample; access to the sample; and the kind of research being undertaken (i.e. mixed methods in the current study) (Cohen et al., 2011: p. 143).
   a. In order to increase the potential sample size and thereby increase participation rates (Cohen et al., 2011), the researcher opted to invite students from two Universities and two Institutes of Technology. The response rate was 19.6% - a total of 107 completed questionnaires from a total e-mailshot of 547.7
   b. The choice of the final four HEIs was generated using a random sampling strategy (Cohen et al., 2011) with the assistance of a statistician at the University of Limerick.8

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7 The breakdown of the 547 is as follows: Uni1 (120), Uni2 (163), IoT1 (76), IoT2 (188)
8 A list was compiled of the 7 Unis and 14 IoTs, each of which was assigned a number from 1 to 21. The statistician used the R programming language to generate random numbers from 1 to 21. The resultant numbers were noted in order, and the list was rearranged in accordance with the numbers that were generated, and the corresponding HEI.
c. **Representativeness of the sample**: the four HEIs were in different geographic locations around Ireland, and collectively offered a broad variety of educational disciplines. By approaching Universities and Institutes of Technology allowed for comparisons across the sectors;

d. **Access to the sample** was obtained with the assistance of the mature student officer or access officer, or ‘gatekeepers’ (Cohen et al., 2011) at each HEI. The mature student officer/access officer would be pivotal in the administration of the survey, as they would facilitate my meeting with the students at induction, send out an information email on my behalf to the mature students at that HEI (Appendix F) with an attached information sheet (Appendix D) and consent form (Appendix G), as well as a subsequent email with the hyperlink to the online questionnaire (Appendix H), and a final email reminding students to participate in the survey (Appendix I).

e. The sampling design in a mixed methods study has implications on the manner in which the study rolls out; this study adheres to a sequential mixed methods design, with quantitative preceding qualitative research, and the data obtained in phase one (quantitative) setting the scene for phase two (qualitative) (Cohen et al., 2011). In this regard, the biographical data, together with the MAS-UK scores obtained through the survey, give an insight into the levels of mathematics anxiety among the cohort of mature students that participated in the survey, that may be further explored in the interview scenario.

3. **Generate the topics to be addressed and the data required in order to meet the objectives of the research.** This step requires the “identification and itemisation of subsidiary topics and involves formulating specific information requirements relating to each of these issues” (Cohen et al., 2011: p. 380). The subsidiary topics required here included biographical data on the student, as well as details about their programme of study; in addition, the questionnaire included the MAS-UK test for completion by the students. This was reproduced with permission from the corresponding author, Dr. Thomas Hunt (Appendix J), and preceded by details for completion.

4. **Decide the kinds of measures/ responses required.** The framing of the questions must reflect the approach to analysis required of the survey, i.e. if the study
necessitates the calculation of frequencies, percentages, and correlations, the framing of the questions must allow for this (Cohen et al., 2011).

5. Write the questionnaire items. and 6. Check that each issue from (3.) has been addressed, using several items for each issue. The questions evolved to their final state through a process of writing, piloting, reviewing, and re-piloting. The questions were designed to allow ease of completion; most of the questions were accompanied by a choice of answers, including dichotomous (e.g. Male/Female) and multiple choice, e.g.

What level programme are you studying?
- Level 6: Higher or Advanced Certificate
- Level 7: Ordinary Bachelor’s Degree/Diploma
- Level 8: Honours Bachelor’s Degree/Higher Diploma
- Other (please specify): ____________________________

Students would have to type their answers to questions regarding their ‘First Language’, and ‘What year did you leave school?’.

7. Pilot the questionnaire and refine items as a consequence. Piloting of the questionnaire enhances the validity, reliability, and practicality of the questionnaire (Cohen et al., 2011). In order to verify the validity, reliability, and practicality of the questionnaire, a pilot test of the questionnaire was issued by email attachment to a representative sample of the population, including mature students at the researcher’s place of work, mature students at the University of Limerick sourced through the assistance of the Mathematics Learning Centre (Appendix K), family members and friends of the researcher who are enrolled as mature students in various programmes of study at HEIs in Ireland and the UK, and colleagues of the researcher. The purpose was to improve the quality of the questionnaire (Cohen et al., 2011; Creswell, 2009), as well as verify that the meanings of the questions posed would be consistent among research participants (Bell, 2005; Seale, 2012). In this regard, the wording of the instructions, questions, and answers is of utmost importance (Cohen et al., 2011). Sample data collected through the initial piloting were tested for suitability for the required analysis, and where lacking, the questions and/or choice of answers were amended to reflect the required options conducive to analysis. This necessitated a re-piloting of the questionnaire to test the suitability of the amendments. Figure 3.4 shows an
example of a question that was modified as a result of the feedback from the pilot phase.

<table>
<thead>
<tr>
<th>Original Question for Pilot Phase:</th>
</tr>
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<tbody>
<tr>
<td>Year of Leaving Certificate (or equivalent) examination ________</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Revised Question for Final Draft of Questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td>What year did you leave school? __________</td>
</tr>
</tbody>
</table>

**Figure 3.4 Example of Question changed after Pilot Phase**

Feedback on this question from pilot respondents included that the person may not have sat a Leaving Certificate (or equivalent) examination, nor have been in school long enough to do senior cycle. The intention behind this question was to gain an insight into the time that had elapsed since the respondent had last engaged with school mathematics. In this regard, the original question was revised. After the required revisions were made, the questionnaire was re-piloted among a smaller sample, including mature students and colleagues at the researcher’s place of work.

8. **Administer the final questionnaire.** The questionnaire was administered with the assistance of the mature student officer or access officer at each HEI. To facilitate ease of distribution and collection of data, the researcher opted to distribute the questionnaire using the online platform Survey Monkey (www.surveymonkey.com). A pilot test of the online questionnaire was distributed to colleagues and mature students at the researcher’s place of work, to ensure the online format made sense to the respondents, and that the collection of results was what the researcher intended. This change in approach was conveyed to – and approved by – the Ethics committee at University of Limerick (Appendix L) before the questionnaire was distributed. Having received initial correspondence about the survey, mature students were sent a follow-up email via the mature student officer/access officer which contained the hyperlink to the questionnaire designed using Survey Monkey. The functionality of this software was familiar to the researcher prior to commencing the study, and the benefits of this approach that were relevant to this study included fast administration of the
survey, ease of access to the desired population, appeal of online questionnaires, ease of collation of data after close of the survey (Cohen et al., 2011).

3.2.1.2 Challenges Posed by the Survey Method

A considerable challenge was gaining access to mature students, which necessitated making contact with 12 HEIs before the desired number of two Universities and two Institutes of Technology was attained. In hindsight, the time of year when the HEIs were contacted coincided with the summer months of July and August, whereby staff may choose to take holidays, and which may have accounted for non-response to phone messages and emails.

The ‘distance’ involved with facilitating an online survey meant having to send the hyperlink to the questionnaire via a mature student officer/access officer. In this regard, the support of the mature student officers/access officers was invaluable. Also, in the initial planning stages of the survey, the researcher had hoped to be able to distribute the questionnaire in person to the mature student cohorts at each of the four HEIs. However, due to logistical issues on the part of each HEI, in particular not being able to facilitate a suitable time for the researcher to distribute the questionnaire, it was decided it would be best to distribute the questionnaire via email hyperlink. Thus, it would have been preferable to have been present at each HEI in person to distribute the questionnaire, in case a participant had any issues with it; in addition, it may have increased the response rate at each HEI.

Having made initial contact with the relevant HEIs, two mature student officers/access officers expressed concern about a questionnaire with the theme of Mathematics Anxiety being presented to new first year students at induction; they feared it might be off-putting for the students before they had even started their programmes of study. Consequently, with agreement from each mature student officer/access officer the researcher decided to delay the rollout of the survey until after the first six weeks of term had passed, which resulted in the rollout being in the last week of October 2015.

The initial response to completion of the questionnaire was very low – 5 completed questionnaires after two weeks of being live. This required further contact with the mature student officer/access officer at each HEI to send out a further e-mailshot as a reminder. One mature student officer/access officer informed me that the timing of the second e-mailshot coincided with many students having to submit assignments and prepare for
examinations, which may account for limited interest. While there was some improvement, the poor uptake necessitated a further (third) e-mailshot, and this time an incentive by way of a gift voucher for one respondent from each HEI was offered to all students who completed the questionnaire.

Deciding when to close access to the online questionnaire was also a contentious time. On the one hand I wanted to allow time to get as many responses to the survey as possible; on the other hand, the time of year – late November, early December – was the end of semester for many of these students, and the first week of December seemed like an appropriate time to close access to the survey.

The challenges of using an online questionnaire became apparent during the survey process, including ensuring that the respondent understood – and responded appropriately to – all questions; the inability to probe the respondent for additional detail on their answers; or the impact on reliability whereby there is no guarantee about the authenticity of the responses, in terms of either the person that completed it or the correctness of the responses given (Cohen et al., 2011; Mertens, 2015). Where a student had difficulty understanding a question, they had email contact details for the researcher; due to the method of distribution of the online questionnaire, there were no individual contact details for the students unless they provided a contact phone number or email address at the end of the questionnaire; and to check correctness of responses, some questions allowed for cross-checking of responses, e.g. question 14 where respondents typed how they felt about mathematics in another programme of study; question 15 where respondents rated their feeling towards mathematics at four stages of their lives; question 19 which asked respondents about their feelings about mathematics at that moment; and the MAS-UK test itself.

Phase one gave an insight into the levels of mathematics anxiety among 107 mature students studying in higher education who engage with service mathematics as part of their undergraduate programme. Initial analysis of these quantitative data presented an overview of the variety of levels of mathematics anxiety among this cohort, whose MAS-UK scores ranged from 23 to 94. These scores indicated a cohort with various levels of mathematics anxiety, ranging from ‘not at all’ to ‘much’. No candidate presented a total score equating to a ‘very much anxious’ outcome (mainly 5’s). This outcome was of interest in that the researcher expected there would be some candidate that would
demonstrate high scores on the MAS-UK, due to the anecdotal evidence conveyed to the researcher, which suggested very high levels of anxiety toward mathematics among mature students. In turn, this finding enhanced the desire to further investigate the stories behind the quantitative findings, to ascertain the more complete picture in respect of mathematics anxiety among these mature students.

3.2.2 Phase Two: Qualitative

In order to understand the mature students’ experiences with mathematics and hear the stories behind them, phase two used a qualitative approach to address the second research question: *To what extent do specific incidents in a mature student's mathematics life story give rise to the level of mathematics anxiety that the student experiences?* Research into an individual’s past experiences can be facilitated using a variety of methods to collect data, including both quantitative and qualitative approaches (Mertens, 2015). The focus on the individual’s past in order to understand their history facilitates an understanding of their present (Dhunpath & Samuel, 2009; Mertens, 2015). However, critics of historical research contend that “history is an elaborate fiction produced by the human imagination: the past existed once, but we can never know it, so we essentially make it up” (MacRaild, 2008: p. 115, cited in Mertens, 2015: p. 280). Mertens, however, advocates the importance for educators to know history in order to gain a full understanding of the present and be in a “position to address the future” (Mertens, 2015: p. 281). In this regard, the researcher acknowledges the significance of understanding the past experiences of mature students in order to gain an insight into how and why they engage with mathematics currently, and consequently, what this might mean for practitioners – lecturers and teachers of mathematics – in their future practice.

3.2.2.1 Life Story Research Method

The use of autobiographical or biographical means assists in the exploration of meaning and the importance (Field, Merrill & West, 2012) of aspects of a person’s life, particularly at times of significant change or transitional points. The life story method of research facilitates examination of the life course as ‘an internalised and evolving narrative of the self that incorporates the reconstructed past, perceived present, and anticipated future’ (McAdams, 1996: p.307). McAdams cites Cohler & Cole’s (1994) contention that a life story is organised ‘with a potential listener or reader in mind and with an intent, often implicit, to convince self and others of a particular plot or present ordering of experience
rendered sensible within a particular culture’ (McAdams, 1996: p. 301). Particular episodes that stand out in a person’s life story are referred to as ‘nuclear episodes’ which are considered important because of what that memory represents in the context of the narrator’s life today (McAdams, 1996).

The life story approach as applied to the context of research into mathematics anxiety represents a suitable method of exploring and eliciting the experiences of students of mathematics during the course of their engagement with mathematics throughout their lives (Coben & Thumpston, 1995; Drake, 2006; LoPresto & Drake, 2004). The researcher must infiltrate and understand the world of the narrator (Denzin, 1978), and in this regard the researcher must develop skills to challenge the subjectivity of the life story (Briggs, 1994), and expose the social experiences and conditions of the narrator, which might otherwise be obscured by ‘the rush to the quantitative’ (Goodson, 2012: p. 35). The intention is ‘to gain new knowledge and insights about a person’s past experience’ (Mertens, 2015: p. 291).

3.2.2.2 A Narrative Approach

Accounts of events are composed for a particular audience at a particular time, using discourses and values that are reflective of the narrator’s culture (Riessman, 2008) and habitus (Bourdieu, 1984). The narrative, presented as a story (Denzin & Lincoln, 2013), is described as “strategic, functional, and purposeful” (Riessman, 2008: p. 8), involving the realisation of certain goals, and is used to make sense of life experiences (Freeman, 2002, cited in Riessman, 2008). The recollection of – and reflection on – past events is used to make sense of the present (Bathmaker & Hartnett, 2010), helping to bring structure to a human life often portrayed as chaotic and lacking temporal structure (Goodson & Gill, 2011).

The explanations presented by the narrator reflect the subjective experiences as determined by the narrator themselves (Denzin, 1978). The narrative is a re-presentation of the experiences (Bold, 2012), with the focus being on the stories being told by the narrator themselves (Polkinghorne, 1988). The researcher receives and recreates the narrative based on their own prior knowledge and interpretation of what has been portrayed (Bold, 2012). In order to make sense of these experiences, the researcher needs to accept the significance of the subjective meaning within its context and acknowledge the need for reflexivity as part of the meaning-making process (Bold, 2012). Research is
conducted “with rather than on” the research participants (Fraser, 2004: p. 16, emphasis in original), thereby acknowledging the research participant as knower (McDonagh, Roche, Sullivan & Glynn, 2012), as well as facilitating reflexivity. As a co-creator of knowledge (Edwards, 2012) the researcher can attain a deeper understanding of both the research process and the roles played by the narrator and researcher in constructing them (McKay, 2000).

3.2.2.3 Approaching Life Story Research

The life story method facilitates understanding of the narrator’s life (Habermas & de Silveira 2008) in the narrator’s own words (Plummer, 2001). As a narrative method of inquiry, also described as ‘autobiographical narrative’ (Foster, 1995 cited in Hatch & Wisniewski, 1995), the life story method involves asking, eliciting, or prompting (Munro, 1998; Plummer, 2001) people to talk about their lives, to make sense of their lives (Wellington, Bathmaker, Hunt, McCulloch & Sikes, 2012) to tell their stories from their unique perspectives (Atkinson, 1998). While word-based exchanges are common in narrative research (Bold, 2012), other means of communication, including visual, gesture, and various media effects are employed (Bold, 2012; Riessmann, 2008). Life stories are interpretations of the life as lived (Goodson, 2016; Goodson & Sikes, 2001) and represent attempts to understand how the past life is connected to the present life (Roach, 2005). The life story method provides an opportunity for the narrator’s experiential knowledge to emerge, reflecting a departure from the positivist tradition and acknowledging the need to facilitate meaning-making and discussion around the challenges encountered in their lives (McColl & Wittner, 1990: p.47). Life stories are detached from the life experiences: the words used to describe the individual’s life experiences are different from the experiences themselves (Altheide & Johnson, 2013); consequently, the personal story is always tentative (Bold, 2012).

Life story research facilitates the portrayal of the narrator’s life from their perspective, using their descriptions of events, and without excessively subjecting these to external constructs (Hummel, 2007). The depiction of the life story is dependent on the words used by the narrator; these are selective (Bathmaker & Hartnett, 2010), and chosen by the narrator with the intention of revealing a particular identity of the narrator (Goodson, 2016). Complete and total understanding of another – by means of the stories they tell – is limited, and the portrayal of one's life story is influenced by how the narrator wants
their story to be presented to the researcher (Dhunpath & Samuel, 2009; Goodson & Sikes, 2001); the narrator selects the account they present, the extent of which is influenced by factors including the setting, the context, the impact of memory, and the relationship to – and power dynamic with – the researcher (Bold, 2012; Goodson & Sikes, 2001). Consequently, the life story is subject to distortion, omission, reduction, and elaboration (Dhunpath & Samuel, 2009), and acknowledges the complexities of the life as experienced by the narrator (Dhunpath & Samuel, 2009). Thus, the living of a life and the telling of a life cannot be the same (Plummer, 2001).

The experience of sharing a life story can be therapeutic (Atkinson, 1998; Brinkmann & Kvale, 2015; Witherell & Noddings, 1991) and can bring numerous benefits to the narrator, including clarity, meaning, awareness, relief, empathy, and community (Atkinson, 1998: p.25/6) as well as a sense of relief, as they have been afforded an opportunity – perhaps for the first time – to reflect on and tell their story, and express their own thoughts and feelings (Atkinson, 1998; Brinkmann & Kvale, 2015; Gubrium & Holstein, 2009). There is space for the narrator’s voice to be heard (Atkinson, 1998), and received by an interested and compassionate listener (Witherell & Noddings, 1991); however, the listener may also be affected by what is conveyed and may identify with particular aspects of the story (Atkinson, 1998). Positive or negative events that evoke emotion are recalled within a short time of being asked (Davis, 1990; Newby-Clark & Ross, 2003). Accounts of upsetting events present with more detail compared with those of happier events (Berntsen, 2002). Negative episodes, particularly, stand out as individuals have to move on from these and deal with the effects of these episodes (Newby-Clark & Ross, 2003). Some events in the life story have no audience, due to the nature of the event, which may have resulted in trauma or shame for the individual, and who is consequently unable to convey this story, thus placing less emphasis on these events (Bluck & Habermas, 2000, citing McAdams, 1998).

3.2.2.4 The Life Story Interview

The collection of the individual’s life story contributes to the overall formation and coming together of the individual’s past experiences (Goodson & Sikes, 2001). The narrative approach facilitates an understanding of the actions and decisions taken by individuals and allows them to use their own words – their stories – to make sense of their lives (Drake, 2006), thereby allowing the narrator to create as full a picture as possible of
their world by telling their story from their own point of view (Hummel, 2007). The life story interview allows the other – the research participant – to speak for themselves and describe their own lived experiences (McColl & Wittner, 1990; Munro, 1998). It is concerned not only with the shaping of the narrator’s experience, but also about the creation of the self (Munro, 1998). The life story interview typically follows a semi-structured or unstructured approach, in order that the narrator has the freedom to talk about their experiences (Drake, 2006; McAdams, 1993). The semi-structured interview is a commonly used tool to enable the elicitation of the research participant’s own narrative accounts (Denzin, 1978; Thumpston & Coben, 1994), and using points of comparison across interviews (Thumpston & Coben, 1994) to facilitate in the collection of data.

Brinkmann and Kvale (2015) describe the interview as ‘an inter-view, an interchange of views between two persons conversing about a theme of mutual interest’ (Brinkmann & Kvale, 2015: p. 4). The research interview is conducted with the intention of talking to the participants, posing questions that will elicit responses that facilitate active understanding and meaning-making (Brinkmann & Kvale, 2015) about the topic being discussed. The interviewer wants to know ‘how they describe their experiences or articulate their reasons for action’ (Brinkmann & Kvale, 2015: p. 3), and the interaction between interviewer and participant is conducted to facilitate the construction of knowledge (Brinkmann & Kvale, 2015).

By virtue of the intention of the interview process, the researcher defines and controls the interview setting (Brinkmann & Kvale, 2015). The researcher may commence the interview with a general question (Atkinson, 1998) or use a question about a specific experience (Brinkmann & Kvale, 2015). Alternatively, the interviewer may commence by asking the narrator to give their life story (Brinkmann & Kvale, 2015).

The account is captured using the narrator’s own language, and with a verbatim transcription of the account (Hummel, 2007). The focus is on the narrator’s explanations of their identity and choices, without – or at least endeavouring to limit – the imposition of external constructs (Hummel, 2007). Consequently, the researcher needs to be aware of the need to let the narrator speak without intervening (McAdams 1993), instead listening carefully with little or no interruption (Brinkmann & Kvale, 2015). Any interjection on the part of the interviewer might be to seek clarification or further
explanation, or to encourage the narrator by way of nodding, and allowing for silence where necessary (Brinkmann & Kvale, 2015). What are presented through the narrator’s accounts are reconstructions of past events, and in this regard, the authentic experience cannot be achieved (Munro, 1998, citing Ricoeur, 1974).

McAdams (1993) endorses an interview protocol for life story research, which involves a duration of between one-and-a-half and three hours and may take more than one sitting. While the interview is a common method – and frequently the only method – of gathering life story data (Caughey, 2006), it may also be supplemented by a variety of techniques, all of which contribute to establishing the identity of the narrator (Caughey, 2006; McCulloch et al., 2013; Roach, 2005) by allowing the narrator to think about and document the topic prior to participation in the interview itself, as well as recording thoughts post interview (McAdams, 1993; Plummer, 2001). Additional techniques include letters, emails, journals, diaries/diary entries, timelines, documentation, and drawings/sketches (Caughey, 2006; Roach, 2005). Research participants in the current study were invited to compile a timeline of their experiences with mathematics and to submit this by email attachment in advance of attending for interview (please refer to Appendix M for request sent to students to participate in Phase 2).

The timeline – as a method of visually portraying a life story (Berends, 2011; Patterson et al., 2012) – may be used as a starting point for life story research (Wellington et al., 2012). The timeline allows the narrator the opportunity to recollect and reflect on significant events (Gramling & Carr, 2004; Patterson, Markey & Somers, 2012), and anonymously display those events in chronological order or sequence (Patterson et al., 2012); this allows for comparison with other timelines with the intention of collating findings within the data to demonstrate prevailing themes, patterns, and connections over time between significant events (Berends, 2011; Patterson et al., 2012). For the researcher, the timeline facilitates an understanding of how the research participant has evolved over time and responded to changing social and historical circumstances (Goodson, 2003). The timeline enables a large amount of data, potentially spanning decades (Berends, 2011), to be condensed and viewed at a glance (Berends, 2011). The limitation of using a timeline alone as research tool is that it loses much of the richness and complexity that can be captured in individual explanations of their experiences (Berends, 2011; Patterson et al., 2012). However, to counteract this, the timeline is more
effectively used in conjunction with the interview process, whereby the latter approach allows the impact of timeline events to be elucidated (Berends, 2011).

3.2.2.5 Frameworks for Life Story Interviewing

Wellington and colleagues (2005) present a framework for devising a personal life story which uses topics to be explored; these include:

- upbringing,
- family background,
- parents’ occupations and education,
- siblings,
- extended family,
- your childhood,
- community and context,
- educational experience,
- higher education and professional preparation,
- occupation,
- personal relationships,
- interests and pursuits.

(Wellington et al. 2005: p. 23)

This approach necessitates extensive sharing of the narrator’s life events, requiring lengthy interview sessions, and frequently subsequent interviews (Drake, 2006; Wellington et al., 2005). By contrast, McAdams’s (1993) earlier work on life story interviews presents a framework for conducting life story research, which comprises seven sections:

Section 1: opening section

In the opening section of the interview the researcher affords the narrator the opportunity to speak generally about their life experience, and is exposed to the approach to storytelling used by the narrator, in particular the tone, the use of imagery, symbolism, or metaphors used to convey what is meaningful to them (McAdams 1993).

Section 2: Nuclear episodes

The opening section is followed by focussing on more specific, key events, or nuclear episodes (Adams 2013) in the narrator’s story; McAdams identifies eight such salient or central (McAdams, 1993: p. 133) episodes:

1. Peak experience (a high point in the life story)
2. Nadir experience (a low point in the life story)
3. Turning point (an episode wherein you underwent a significant change in your understanding of yourself)
4. Earliest memory (one of the earliest memories you have of an event that is complete with setting, scene, characters, feelings, and thoughts)
5. An important childhood memory (any memory from your childhood, positive or negative, that stands out today)
6. An important adolescent memory (any memory from your teenage years, positive or negative, that stands out today)
7. An important adult memory (any memory, positive or negative, that stands out from age twenty-one onward)
8. Other important memory (one other particular event from your past that stands out).

(McAdams 1993, pp. 258-259)

These nuclear episodes are the ‘most significant scenes’ (McAdams, 1993: p. 134) in the life story of an individual. The interviewer may develop a set of guidelines to explore these further (McAdams, 1996) or alternatively follow a predetermined set of questions devised by another researcher, and which may be modified to suit the relevance of the interviewer’s intention for the interview (McAdams, 1996). In focusing on these key events, the narrator has the opportunity to highlight specific occasions within their life, while ignoring other events (McAdams, 1993). Of particular importance in providing rich, descriptive accounts is that the narrator is given sufficient time to relay each event, with as much detail as they can in order that they can express the significance of the event within the bigger picture of their overall life story (McAdams, 1993).

Section 3: Significant people

Subsequent to the discussion of key events, McAdams recommends focusing on significant people, in positive and negative contexts, with a view to identifying why the narrator chooses the persons they do, and why these individuals are significant (McAdams, 1993).

Section 4: Future life story

The focus then shifts to the consideration of the future life story and how it might evolve, as well as the possible revelation of plans for the future, and how these plans may have an impact on their lives and those of others; this part of the interview also provides an opportunity to see whether there is continuity in how the narrator sees themselves in the
future compared with how they have seen themselves in the past or at this point in time (McAdams, 1993).

Section 5: Stresses and problems
This section strives for the identification of strategies that have addressed – or may address – the stresses and problems identified (McAdams, 1993).

Section 6: Personal ideologies and beliefs
This section asks the participant to talk about their fundamental beliefs and values, including religious beliefs and political orientation (McAdams, 1993).

Section 7: Life theme
The section asks the narrator to consider an overall life theme for their story (McAdams, 1993).

While each of the above two frameworks represents a significant means of approaching a general life story interview, more tailored approaches to life story research are applied where the focus is on specific areas of interest (McAdams, 1993; Plummer, 2001), including the study of mathematics anxiety (Briggs, 1995; Drake, 2006; Stoehr, 2015; Thumpston & Coben, 1994; Tobias, 1993).

3.2.2.6 Variations on the Life Story Interview
The facilitation of a focus on specific events allows the researcher to concentrate on those aspects of the narrator’s life story, thereby reducing the risk of the narrator providing general descriptions (Habermas and de Silveira 2008). In this regard, tailored or structured approaches to the life story interview have been used to elicit more focussed understanding of the participants’ experiences of the topic being investigated (Drake, 2006; McAdams, 1993; Plummer, 2001; Reece et al., 2010; Stoehr, 2015). Plummer (2001) provides the classification of long and short life stories (Plummer, 2001). He equates the long life story to that described by Atkinson (1998), being extensive and taking into account the entire span of life, and thus the ‘key to the [life story] method’ (Plummer, 2001: p. 19). In contrast, short life stories entail a shorter duration, are more common, have more focus, are often published as part of a series, and look into aspects of the lives of typically numerous research participants (Plummer, 2001). He contends that shorter life stories represent ‘truncated’ versions of the long life story, being gathered
using in-depth interviews, with ‘open-ended questionnaires, requiring gentle probes and taking somewhere between half an hour and three hours’ (Plummer, 2001: p.20).

Building on the work of Allport (1942) Plummer puts forward three forms of presenting a life story: comprehensive, topical, and edited. Comprehensive life stories aim to capture the ‘totality of a person’s life … from birth to their current moment’, which Plummer contends is impossible, without approaching the life story from a particular perspective (Plummer, 2001: p. 26). Topical life stories have been used as tailored or structured approaches to elicit more focussed understanding of the participants’ experiences of a topic being investigated (Drake, 2006; McAdams, 1993; Plummer, 2001; Reece et al., 2010). Edited life stories include the interviewer’s voice, with that of the participant being used for illustration in the form of extracts (Plummer, 2001: p. 27). Thus, in the context of research into mathematics anxiety, a hybrid approach to life story interviewing was favoured for the current study, involving the use of a short, topical life story method (Plummer, 2001) explored or expanded upon using aspects of McAdams (1993) framework that are reflective of a person’s engagement with mathematics throughout their life, and therefore relevant to tapping into the experiences of mature students in order to elicit accounts of those times in their lives where engagement with mathematics would be of significance.

3.2.2.7 The Mathematics Life Story

The life story method facilitates understanding of how individuals have dealt with situations – particularly challenging ones – and in doing so offer an insight into possible solutions to these situations (Goodson & Sikes, 2001). As a variation of the life story, the mathematics life story presents the researcher with an individualised account of the narrator’s past and present experiences with mathematics. In this way, significant events may be elicited which may provide an insight into factors that contribute to the challenges posed by mathematics, as well as strategies to overcome issues with mathematics (LoPresto & Drake, 2004). LoPresto and Drake (2004) used a variation of McAdams’s life story protocol to elicit the mathematics stories of their students. The structure of their story comprised four parts: ‘critical events, challenges, influences, and future’ (LoPresto & Drake, 2004: p. 268). The benefits of mathematics life stories are threefold; first, they ‘give instructors insight into the background of their students; (2) [they] allow students to reflect on their background with hope that they will continue to reflect throughout [their
studies in mathematics]; and (3) [they] aid instructors in planning and focusing instruction’ (LoPresto & Drake, 2004: p. 268).

Mathematics life stories present researchers with an opportunity to learn about students’ experiences of mathematics by facilitating the elicitation of descriptions of feelings about mathematics and what they think about mathematics. An insight can be gained in respect of their likes and dislikes in mathematics, as well as the methods that do or do not work for them as they engage with mathematics (LoPresto & Drake, 2004). This approach contrasts with the use of a survey into attitudes and beliefs, especially using Likert scales, in that it facilitates the presentation of a chronology of events (LoPresto & Drake, 2004) that can be expanded upon within the context of a mathematics life story interview (Drake, 2006; LoPresto & Drake, 2004). The combination of survey and mathematics life story interview, however, can bring to light a more comprehensive insight into the narrator’s experiences with mathematics (LoPresto & Drake, 2004).

3.2.2.7.1 Conducting the Mathematics Life Story Interview

The initial interview framework considered for the present study is presented in Figure 3.5, the components of which constituted the indicative topics for discussion in the individual interview with each mature student. After the first life story interview had been conducted, the approach taken to each subsequent life story interview was informed and influenced by previous interviews, and in this regard, assisted the process of fine-tuning the questions posed by the researcher in subsequent interviews to adequately reflect the needs of the research study (Miller, 2000). After the second interview, the above framework necessitated adjustment, as there was overlap in the sections looking at ‘Earliest Memory’ and an ‘Important Childhood Memory’ with respect to mathematics.
In addition, the importance of mathematics as part of the decision-making process to enter higher education was an apparent omission from the above with regard to the approach to conducting the mathematics life story. Consequently, the above framework was revised, as is reflected in Figure 3.6 and formed the basis for the remaining life story interviews conducted in this study.

**Figure 3.5 Initial Interview Framework for Mathematics Life Story Interview**

In addition, the importance of mathematics as part of the decision-making process to enter higher education was an apparent omission from the above with regard to the approach to conducting the mathematics life story. Consequently, the above framework was revised, as is reflected in Figure 3.6 and formed the basis for the remaining life story interviews conducted in this study.

**Figure 3.6 Revised Framework for Mathematics Life Story Interview**


3.2.2.8 Challenges of Using the Life Story Approach

The life story approach presents a number of challenges: the credibility of the data (Goodson & Sikes, 2001; Troyna, 1994); the relationship between the individual lives and the social settings especially in respect of the complexity of lives, and the ways in which a person tells their account of the topic being studied (Goodson & Sikes, 2001); the power of the informant in respect of the data they make available to the researcher (Goodson & Sikes, 2001); the possibility that the life story interview can result in life-changing outcomes for the narrator (Goodson & Sikes, 2001); the challenge – for the researcher – of presenting the actual life of the narrator as they have conveyed it (Bold, 2012; Goodson & Sikes, 2001).

A life story inevitably makes reference to the experiences of others, as well as those of the participant; consequently, the story presented omits the perspective of the other agents (Suitor & Pillemer, 2003). However, it is the researcher’s aim to capture the perspective of the narrator as ‘insider’ (Atkinson, 2000: p. 134) into their life as they have experienced it, since the narrator is the expert and the authority on their own life, and to this end, they provide a unique perspective (Atkinson, 2000).

A life story is personal to the narrator, and requires that aspects of one’s life be revisited, re-examined and retold (Cole & Knowles, 2001; p. 41); it involves the presentation of events, but in addition, the organisation of one’s experience. It is the storyteller who presents the components of the story as related to each other within the present context in order to affirm the meaning of their story (Cole & Knowles, 2001: p. 19).

The situation encountered provokes the telling of the life story (Wethington, 2000). Life stories emerge in order to explain events that have taken place in the past, or to explain events that are to take place in the future. As participants share their stories, both positive and negative, they have the opportunity to express their experiences, so that others can learn from them (Mazzei & Jackson (2009), cited in Sandberg, 2016). For the researcher, there must be an acceptance that the accounts provided by the narrator can help to illuminate the topic under investigation, rather than expecting they will provide ‘hard facts’ (Dhunpath & Samuel, 2009), and in this way, facilitate the co-construction of knowledge by the narrator and the researcher in respect of the topic of the study under investigation (Matiss, 2005).
In focussing on the historical changes in the narrator’s life story (Matiss, 2005), the delivery of this account by the narrator moves between the personal story and those factors external to them that have impacted upon them (Plummer, 2001). Gubrium and Holstein (2009) contend that any experience does not have meaning by itself; the meaning comes by linking experiences to other elements of the research participants’ story and the contexts for understanding those stories.

3.2.2.9 Life Story Interview Guidelines

In the face-to-face interview, the narrator – the focal subject (Denzin, 1978) – presents personal and subjective experiences of interest to the researcher (Sikes, 2016). The life story interview stipulates a particular approach in order to maximise the outcomes of the interview process, thereby obtaining a rich dataset. Atkinson (1998) advocates some basic interview guidelines for approaching the life story interview:

a) ‘who do you want to interview (be humane, empathetic, sensitive and understanding)
b) explain your purpose (research purpose, anonymity, recording, rapport)
c) take time to prepare – (objects of memory)
d) create the right setting
e) get the story – open-ended interview (get at the meaning behind the event; direct and simple questions)
f) interview is not a conversation (your knowledge and voice remain in the background, providing support and encouragement)
g) be responsive and flexible (eye contact, enthusiasm, comfortable, ask for clarification)
h) be a good guide (the right follow-up questions or comments, best judgement)
i) listen well (be a witness to what is said, caring about the interviewee; connecting with the interviewee)
j) emotions will emerge (recalling different memories; be sensitive and accepting)
k) be grateful (a valuable gift to you and others).’


The interview process demands consideration of the ethical issues that arise, necessitating fairness, honesty, clarity, and simplicity in this interaction between researcher and interviewee (Atkinson, 1998).

3.2.2.10 Purposive Sampling

Preparing for the interview requires much contemplation on the part of the researcher in respect of the likely data that would emerge. The researcher carefully selects ‘critical informants’ whose world must be penetrated and understood (Denzin, 1978). The current study used purposive selection of research candidates to identify individuals who have a
significant connection to the research topic (Seale, 2010). Individuals who participated in the first – quantitative – phase were invited to opt in to participating in the second – qualitative – phase by indicating their preference to do so at the end of the questionnaire. The insights of purposive participants and the data they contribute can help the researcher make comparisons across the individual life stories (Bold, 2012; Seale, 2012; Thumpston & Coben, 1994). This approach also enables the choice of ‘interesting’ or atypical candidates, who can provide insights into aspects of the topic that may not have been considered by the researcher as relevant (Caughey, 2006). This allowed for a variety of participants in terms of the scores achieved on the MAS-UK component of the questionnaire, in that the scores spanned a range of MAS-UK scores.

Central to organising an effective interview is the establishment of a rapport between researcher and narrator to make both persons – and particularly the latter – feel more relaxed. In this regard, correspondence with the narrator in advance of the interview is central to ensuring he/she is aware of the researcher’s expectation of him/her, as well as the agreement of a mutually convenient date, time and location for the interview (Caughey, 2006). All interested respondents to the questionnaire were contacted by the researcher by their preferred method of contact – either text message or email – as indicated in the questionnaire. Initial uptake of the invitation to participate was slow and required a review of the process by the researcher. A subsequent request by text message or email was sent, with the offer of an incentive to participate, namely a gift voucher, which helped increase the response rate.

3.2.2.11 Conducting the Interview

In order to obtain as authentic an account as possible, Lieblich, Tuval-Mashiach and Zilber (1998) endorse an open and flexible approach to interviewing; this can also lead to variations in the protocols used in the interview context, as well as in the variation of data collected from participants (Lieblich, Tuval-Mashiach & Zilber, 1998). This approach can also result in conversations that vary between monologue – with minimal interruption from the interviewer – and dialogue – with more of a question-answer interaction (Lieblich et al., 1998). The pursuit of authenticity may also give way to adhering to a rigid structure of questioning in favour of an openness that allows the participant to talk freely (Lieblich et al., 1998). In the current study, the interview with each of eighteen of the participants was held in a pre-booked private meeting room designated for interviews
of this nature; this was organised in conjunction with the Mature Student Officer/Access Officer at each HEI, and with the approval of each participant. One other interview was conducted by Skype video link as the participant was overseas, and the other was conducted at the participant’s home as she had deferred her place at the HEI and opted to meet at her home.

In order to set ‘the interview stage’ (Brinkmann & Kvale, 2015: p. 154) so as to encourage the interviewee to share their story, the interviewer must ensure the interviewee feels at ease in their company; in this regard, the interviewer must ensure there is clarity about what the interview will entail, demonstrate attentive listening, as well as an interest in and respect for the interviewee (Brinkmann & Kvale, 2015). Prior to meeting for interview, the researcher emailed each interviewee individually explaining what the interview would entail (Appendix M), and in advance the interviewees were also invited to submit a timeline of their experiences with mathematics throughout their lives (a sample timeline is shown in Appendix N).

The semi-structured approach to interviewing is beneficial in that it allows for comparison among research participants (Coben & Thumpston, 1995), as well as the identification of patterns in respect of the participants’ approach to the topic being researched (Drake, 2006). The oral presentation of events provides the researcher with the opportunity to delve further into what the narrator presents, and tease out additional understanding of the contexts that contributed to the experience (Briggs, 1994; Sikes, 2016). It is more appropriate to begin with broad, open-ended questions that encourage, rather than intimidate the narrator (Caughey, 2006). At the start of each interview the researcher thanked the participant for attending and briefly explained the context for and purpose of the interview, acknowledged the use of the audio recorder, and invited the participant to sign the consent form (Appendix G) and ask any questions before starting the recorder (Brinkmann & Kvale, 2015). In order to set the tone for the interview, the opening question asked the participants ‘when you think about mathematics, how does it make you feel?’ In some cases, the participants gave short replies, whereas others spoke for a while sharing experiences of feelings at different points of their lives. The remainder of the interview built on this response and addressed each part of the framework, with the researcher listening to the responses, and occasionally asking for clarification where necessary, as well as assisting the interviewee in continuing with their account (Brinkmann & Kvale, 2015).
Atkinson (1998) acknowledges that different situations, circumstances and settings dictate different approaches by the researcher to asking questions, and indeed to the questions asked; however, the end result comprises a ‘fairly complete life story’ (Atkinson, 1998: p.21) with meanings, memories and interpretations being ‘highly personal’ or ‘an art form’ (Atkinson, 1998: p.21). At the end of the interview the researcher asked the participant if they wanted to add anything else, thanked them for attending and for sharing their story, and turned off the recorder. In some cases the participant expressed relief at having shared their stories, in particular Jon, who admitted he felt ‘a weight had been lifted’ after talking about his difficult experience at school (recorded in my notebook after the interview) and Gayle who admitted she wanted to be successful and felt that mathematics was holding her back, but she was determined to overcome her difficulties with extra support. She also expressed interest in a future interview with the intention of comparing a before and after situation. Before both persons departed the interview setting, the researcher explained what would happen with the recording, i.e. that it would be transcribed, and emailed to the participant for verification.

3.3 Analysis of Data

In a mixed methods study, analysis of one type of data, namely quantitative, can be used to inform a second phase of data collection, i.e. qualitative (Tashakkori & Teddlie, 1998). The approach to data analysis in the current study involved a combination or mixing of techniques (Tashakkori & Teddlie, 1998), including using initial analysis of the quantitative results to inform the design of – and data collection approach used in – the subsequent qualitative phase, and parallel analysis of the two sets of data to enhance the understanding of what is being investigated (Tashakkori & Teddlie, 1998).

The approach taken to data analysis is dictated by the need to address the research questions of the study (Creswell & Plano Clark, 2011). As presented in section 3.1.3 the current study adheres to an explanatory sequential design, comprising distinctive procedures for data analysis design and identifying critical points where decisions need to be made (Creswell & Plano Clark, 2011) to progress with analysis (Table 3.1). Analysis of the data comprises separate analyses of quantitative and qualitative data, using quantitative and qualitative methods respectively (Creswell & Plano Clark, 2011), followed by the combined analysis. The analysis steps are accompanied by key decisions relating to the identification of participants from phase one to participate in phase two.
and determining how the qualitative results facilitate explanation of the quantitative results (Creswell & Plano Clark, 2011).

Table 3.1 Steps and Decisions in Mixed Methods Data Analysis by Design
(sourced from Creswell & Plano Clark, 2011: pps. 217-218)

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<tbody>
<tr>
<td>1. Collect the quantitative data;</td>
<td>Decide what participants to follow up with and what results need to be explained qualitatively.</td>
</tr>
<tr>
<td>2. Analyse the quantitative data quantitatively using analytic approaches best suited to the quantitative research question;</td>
<td></td>
</tr>
<tr>
<td>3. Design the qualitative strand based on the results of the quantitative results;</td>
<td></td>
</tr>
<tr>
<td>4. Collect the qualitative data;</td>
<td>Decide how the qualitative results explain the quantitative results.</td>
</tr>
<tr>
<td>5. Analyse the qualitative data qualitatively using analytic approaches best suited to the mixed methods research question;</td>
<td></td>
</tr>
<tr>
<td>6. Interpret how the connected results answer the quantitative and mixed methods questions.</td>
<td></td>
</tr>
</tbody>
</table>

The following section presents the approach to analysis used in this research study.

3.3.1 Step 1: Quantitative Data Collection

Pilot Testing of Questionnaire

The initial attempt at analysis was facilitated using the pilot questionnaires (section 3.2.1.1) that were completed. The data presented in these questionnaires provided an insight into the types of responses and the likely approach to collation and analysis of the data (Cohen et al., 2011).

Questionnaire Components

The questionnaire comprised nine components, including biographical questions, programme-related questions, and the MAS-UK scale. Table 3.2 presents the questionnaire sections and corresponding question numbers.
<table>
<thead>
<tr>
<th>Questionnaire Section</th>
<th>Question Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Background Information</td>
<td>1-5</td>
</tr>
<tr>
<td>B. Programme of Study</td>
<td>6-9</td>
</tr>
<tr>
<td>C. Before you engaged with this Programme</td>
<td>10-12</td>
</tr>
<tr>
<td>D. Other Programmes of Study completed</td>
<td>13-14</td>
</tr>
<tr>
<td>E. How do you rate your Ability in Mathematics</td>
<td>15</td>
</tr>
<tr>
<td>F. Mathematics Support at this HEI</td>
<td>16-17</td>
</tr>
<tr>
<td>G. Mathematics in your future Career</td>
<td>18</td>
</tr>
<tr>
<td>H. How do you feel about Mathematics now?</td>
<td>19</td>
</tr>
<tr>
<td>I. Mathematics Anxiety Scale – UK</td>
<td>20</td>
</tr>
</tbody>
</table>

Biographical characteristics gathered through the survey included gender, date of birth, first language, year the mature student left school; questions relating to the programme of study included the name of the HEI, discipline of study, level of programme, mode of programme (Full time/Part time), if the programme has a mathematics module, the student’s rating of their ability in mathematics; if the student is aware of mathematics support at the HEI, how mathematics features in their future career; how the student feels about mathematics at the time of completion of the questionnaire; and the last component comprised the MAS-UK.

**Distribution of the Survey**

The questionnaire was hosted on Survey Monkey and was distributed as a hyperlink by email to a total of 547 mature students at two Institutes of Technology (IoT) and two Universities (Uni), hereafter identified as IoT1, IoT2, Uni1, and Uni2. Responsibility for the email distribution of the online survey was held by the researcher in the case of IoT2⁹, and with the Mature Student Officer/Access Officer at IoT1, Uni1 and Uni2.

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⁹ At the time of student induction, students had not yet been issued with their student email addresses. To this end, the access officer suggested the personal email addresses of willing participants be collected there and then at the induction meeting. The researcher sent around sheets of paper to collect email addresses of willing participants among the cohort. These email addresses were used by the researcher to contact these students by email with the hyperlink to the questionnaire.
Data Reduction

The collation of the data from the completed questionnaires required that the findings be downloaded from Survey Monkey in a Microsoft Excel (hereafter MS Excel) spreadsheet format. This allowed the researcher to prepare the data for analysis (Cohen et al., 2011), prior to uploading the data to the dedicated statistical analysis program Statistical Program for the Social Sciences (hereafter SPSS). The questionnaire responses were edited: i.e. checked to ensure all questions were answered and that all responses were accurate (Cohen et al., 2011). In this regard, the data set was edited to match the required criteria for analysis, namely that all respondents were full time undergraduate students, had a service mathematics module as part of their programme of study, and had answered all questions on the questionnaire. The total number of responses received was 170, of whom 49 did not have a service mathematics module, and 14 did not complete the questionnaire fully; this left a total of 107 questionnaires that were suitable for analysis. Thus, the survey yielded a final response rate of 19.6% (n=107).

3.3.2 Step 2: Analysis of the Survey Data

In order to protect the identities of the respondents, questionnaires were completed anonymously. However, if the participant was interested in participating in phase two of the study, they were invited to provide an email address or mobile phone number (for text message or phonecall correspondence). The questionnaire remained live for approximately 6 weeks. Having closed the online survey, it was necessary to download the completed survey results. This is facilitated through Survey Monkey by collating the data into a MS Excel 2013 spreadsheet to be downloaded. While MS Excel affords the user many functionalities for statistical analysis, the researcher opted to import the MS Excel data into a dedicated statistical analysis software program, namely SPSS version 2210.

Stage one data analysis adhered to Creswell and Plano Clark’s (2011) data analysis procedures for mixed methods studies, which comprises six steps: preparing the data for analysis, exploring the data, analysing the data, representing the data analysis, interpreting the results, and validating the data and interpretations (Creswell & Plano Clark, 2011: pps. 204-212):

10 Over the course of this study, SPSS versions 22 and 24 were used.
a) **preparing the data for analysis** involved assigning numeric identities to each respondent, cleaning data entry errors, and developing a codebook to explain the significance of numerical entries.

b) **exploring the data** involved a visual inspection of the data and using descriptive statistics to provide an insight into general trends within the dataset. This was facilitated using SPSS.

c) **analysing the data** involved analysing the data with consideration of research question one; building on the descriptive statistics’ results, the data are analysed using inferential methods. This was facilitated using SPSS.

d) **representing the data analysis** involved the use of tables and figures to present the findings of the analysis in summary form.

e) **interpreting the results** involved considering the results in light of the first research question, as well as comparing the results with the literature.

f) **validating the data and interpretations** involved ascertaining the validity and reliability of the data by ensuring the data were collected and analysed in a consistent and accurate way.

(Kelly, 2012)

The MAS-UK scores were analysed to identify the range of scores among the cohort, looking at total scores, and comparing these with other factors including HEI attended, and Gender. In addition, the individual items of the MAS-UK were analysed in light of the scores given by the participants, to ascertain which statements gave rise to high levels of anxiety (scoring 4 or 5) and by contrast low levels of anxiety (scoring 1 or 2). The stage one analysis helped to identify candidates that would be targeted for purposive sampling in phase two, the mathematics life story interview.

### 3.3.3 Step 3: Design the Qualitative Strand

**Key Decision: Decide what participants to follow up with and what results need to be explained.**

In preparation for phase two, the researcher wanted to select candidates that demonstrated low, middle, and high levels of mathematics anxiety, in order that comparisons could be made across participants in order to address the second research question. A total of 64 of the 107 respondents to the questionnaire had opted in to participate in phase two. In order to acquire candidates for interview with low, middle, and high levels of mathematics anxiety, the researcher invited three each with low, middle, and high MAS-UK scores from each HEI to participate in phase two. Initially, the response rate was very poor, and after a two-week period, the researcher decided to extend the invitation to all 64 candidates who had opted in to participating in phase two. It is likely that the time lapse from completion of the questionnaire (October/November) to the email request to participate in phase two (March) was too long in order that participants would have
maintained interest in the study (Creswell & Plano Clark, 2011). Consequently, an e-mailshot to all 64 respondents was sent, resulting in twenty-one respondents expressing an interest in meeting for interview, of whom twenty attended for interview.

3.3.4 Step 4: Collect the Qualitative Data

The qualitative data comprised primarily the data obtained by way of the interview process (as described in section 3.2.2.7.1). The interview format adhered to the Framework for the Mathematics Life Story Interview (Figure 3.6). The date, time and location of the interview was mutually agreed by the researcher and research participant. The interviews were recorded and the transcribed. Subsequently the typed transcript was emailed to each research participant for clarification that the content was an accurate reflection of the interview. In addition, in order to anonymise the data, each participant was invited to confirm a pseudonym to be used to identify their transcript.

3.3.5 Step 5: Analysis of the Qualitative Data

The purpose of qualitative analysis is to thoroughly investigate the meaning of the situations presented and to grasp the ways in which people understand the world (Bold, 2012). However, Bold acknowledges that analysis is complex, a process that requires numerous iterations, and thus is difficult to relate to one particular structure (Bold, 2012: p. 122). The structure is emergent and specific to each interview. While the number of participants in a life story study is typically small, the experiences and stories that emerge from the analysis and interpretation resonate with others who have similar experiences and stories to tell (Bold, 2012: p. 121).

McAdams (1993: p. 252) describes the purpose of the life story interview as the “gaining of knowledge about real people’s real lives” (McAdams, 1993: p. 252), and the analysis of the data requires differentiating between the various themes that emerge. Of importance here is the chronology of events in contributing to the understanding of the experiences of the individual – and the sequencing of these – over time (Gramling & Carr, 2004). Thematic analysis of stories allows for comparison between different individual’s accounts (Riessman, 2008), as well as looking at an individual’s entire story as it evolved (Sandalowski, 1991).

Thematic analysis relies on prior knowledge of theory about the topic in order to facilitate interpretation of the narrative and the identification of common themes among research
participants (Riessmann, 2008). In addition, new theoretical insights may also be encountered during analysis (Riessmann, 2008), rather than being determined from the beginning (Atkinson, 1998). Riessmann advises against segmenting the story in favour of keeping the story and its sequences intact to allow interpretation. Consideration of time and place in the narrator’s story, as well as considering each life story as an individual case is central to thematic analysis (Riessmann, 2008).

The analysis of data commences with the initial collection of data in the form of an iterative process, as the findings of the first interview scenario can help to inform – and, if necessary, modify – the approach taken by the researcher to subsequent interviews (Miller, 2000). The findings of stage one helped to inform the development of the mathematics life story interview framework, which was used to conduct the mathematics life story interviews. In order to gain a deeper insight into mathematics anxiety among mature students, it was necessary to look at the engagement of these students with mathematics during their lives and guided by the adapted framework (Figure 3.6). Using this framework, overarching mathematics life story themes are pre-determined and form the basis for initial analysis of the interview transcripts (Miller, 2000); however, within each theme, sub-themes are emergent and sometimes unique to individual participants (Miller, 2000).

Qualitative data analysis also adhered to Creswell and Plano Clark’s (2011) data analysis procedures for mixed methods studies (Creswell & Plano Clark, 2011: p. 204) with six steps: Preparation of the data for analysis; Exploring the data; Analysing the data; Representing the data analysis; Interpreting the results; and Validating the data and results.

a) Preparation of the data for analysis involved transcribing the text verbatim from the interview recording into a Microsoft Word document. The typed transcript is then compared with the recording for accuracy of the typed representation. Atkinson (2002) contends that the way in which the interview is transcribed is dictated by the purpose of the research. In life story interview transcription, the voice of the participant needs to be presented in its authentic form, with little, if any, input from the interviewer. Finally, the transcripts are imported into a qualitative data analysis (QDA) computer software program, i.e. NVIVO, to facilitate the management of data analysis. In the current study, the first interview transcription – a fifty-two minute interview – took approximately ten hours for
the researcher to transcribe, and an additional two hours proofing the transcription. Due to personal time constraints, the researcher opted to outsource the transcription of the interviews to a professional transcription service. On receipt of the completed transcripts, the researcher compared the transcription with the recording to verify the quality and clarity of the transcription (Brinkmann & Kvale, 2015; Cohen et al., 2011). The completed transcripts were imported into the NVIVO QDA program.

b) **Exploring the data** involved “reading through all of the data to develop a general understanding of the database” (Creswell & Plano Clark, 2011: p. 207). This involved reading through the transcripts in conjunction with field notes and memos.

c) **Analysing the data** involved coding the data and grouping the codes to form themes. Kowal and O’Connell (2014) define coding as the “classification of events in discrete categories and the labelling of these categories” (Kowal & O’Connell, 2014: p. 67, in Flick, 2014). They continue: “coding is logically dependent on previous transcription and entails a further theoretical orientation as foundation for its categorisations” (Kowal & O’Connell, 2014: p. 67). The initial coding was done manually using the printed transcript, a highlighter and a pen (Figure 3.7).

Reference 1 - 5.07% Coverage

I was *quite comfortable* with it in my early years going through primary and late into secondary school would have done higher level maths for junior cert. I stuck it out until probably I can’t remember now was it the year of the first year of *leaving cert course* or if I took it through to the following year, I’m not sure but I just *found the going very heavy* and it was almost like trying to study two subjects because it was just the *volume of work* and you had to get to through and everything and it took off to a *more difficult level*. Then, yes, I done an *apprenticeship*, it was electrician. Okay a little bit maths based but not too heavy and then two years ago there went back to college studying marine electrotechnology and to be fair I did struggle with the maths and the *in class tests* I was failing but somehow or another through the end of the semesters I was scraping a pass which was good *enough to get through the semester* and so on.

**Figure 3.7 Example of Manual Coding of the Transcript Data**

The researcher opted to code the transcripts manually in order to familiarise herself with the data (Brinkmann & Kvale, 2015; Mertens, 2015). This was
followed by electronic coding of the transcripts using NVIVO. The transcripts as Microsoft Word documents were imported into NVIVO; in the NVIVO coding interface, relevant sentences or paragraphs were highlighted and dragged onto the corresponding ‘node’ or named code (Figure 3.8).

In Figure 3.8 the main screen is divided into four sections: the left-most section shows the application of NVIVO being accessed at the time (Nodes) and its sub-folders, as well as other functionalities of NVIVO (i.e. Sources, etc.); the next section shows the list of open codes, and to the right of that is a sample transcript with sentences highlighted for the code ‘self-confidence.’ The user can highlight the sentences and drag them into the pre-created node ‘Self-Confidence’ or if it is a new node, the user can drag the sentences to the bottom of the open coding section where a new node can be created, i.e. assigned a name and a description. The section of the screen on the right shows the coloured coding stripes, which indicate the extent of coding within that section of the transcript, and the codes assigned to the text.

The coding frame (Schreier, 2014) is central to the process of qualitative data analysis and comprises four steps: “selecting material; structuring and generating categories; defining categories; and revising and expanding the frame” (Schreier, 2014: p. 174):
i. The selection of material must represent the variety of data sources, for example interviews with different participant groups (such as mature students exhibiting low, middle and high scores on the MAS-UK).

ii. Main and subcategories are generated using either concept-driven categories or data-driven categories, or a combination of both (Schreier, 2014). Concept-driven categories use previous knowledge – such as a theory or interview questions – to form the main coding categories (Schreier, 2014); while data-driven categories comprise the sub-categories. The analysis of the interview transcripts was structured by the adapted McAdams framework, which provided *a priori* themes with which to conduct an analysis of the transcripts. *A priori* theme analysis involves applying predetermined categories (Tashakkori & Teddlie, 1998) to frame the coding scheme. Table 3.3 shows the *a priori* categories and corresponding codes used in NVIVO. These *a priori* categories represent the broad themes of this study, within which sub-themes emerge as a result of the coding process. Some code names were influenced by the Framework questions, for example Primary School, Strategy with mathematics, Feeling about mathematics; Personal Theme or Characterisation; however most codes were assigned according as the transcript was read and a code could be identified as significant, using a word or phrase that described the piece of text simplistically, without requiring interpretation (Seale, 2012).

**Table 3.3 A Priori Categories and Corresponding Code Names**

<table>
<thead>
<tr>
<th>A priori category</th>
<th>Code name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early memories of mathematics, including mathematics at primary school</td>
<td>Primary</td>
</tr>
<tr>
<td>Mathematics at post-primary school</td>
<td>Post-Primary</td>
</tr>
<tr>
<td>Mathematics after school, including in the work environment</td>
<td>After school</td>
</tr>
<tr>
<td>Mathematics in their current programme of study at third level</td>
<td>Third Level</td>
</tr>
<tr>
<td>(including the decision to apply to third level and the role of mathematics in that decision)</td>
<td></td>
</tr>
<tr>
<td>Significant others</td>
<td>People</td>
</tr>
<tr>
<td>Strategies to overcome stresses and problems with mathematics</td>
<td>Strategies</td>
</tr>
<tr>
<td>Future script</td>
<td>Future</td>
</tr>
<tr>
<td>Theme for overall mathematics life story</td>
<td>Personal Theme</td>
</tr>
</tbody>
</table>

In order to organise the open codes into categories, a new folder named ‘Phase 2 - Framework Categories’ with subfolders for each of the ten Framework questions was added to the first section of the NVIVO
workspace (Figure 3.9), into which the initial codes could be placed (dragged) according to categories; the right hand section of the screen in Figure 3.9 shows the thirteen codes for the category ‘Mathematics at Third Level.’

Figure 3.9 Screenshot of NVIVO showing Phase 2 – Framework Categories with Subfolders, and Contents of Subfolder Mathematics at Third Level

Sub-categories are created as subordinate to the main categories using the following steps proposed by Mayring (2010, cited in Schreier, 2014):

1. Reading the material until a relevant concept is encountered.
2. Checking whether a subcategory that covers this concept has already been created.
3. If so, mentally ‘subsuming’ this under the respective subcategory.
4. If not, creating a new subcategory that covers this concept.
5. Continuing to read until the next relevant concept/passage is encountered.


With this approach the researcher must consider the need to develop a new subcategory based on the data at-hand; a comparison must be made with subcategories already created (if applicable), in order that there is no duplicating of sub-categories, and until a point of saturation has been reached (Schreier, 2014). In the present study, the researcher had initially coded ‘support from lecturer’ as a separate code from ‘Support inside or outside HEI;’ however, when subcategories were being assigned to the Mathematics at Third Level category, there was duplication of the content of both codes, so it was decided to subsume the former into the latter.
iii. The definition of categories involves four steps: naming the category; describing the category name; giving relevant examples; and stating decision rules.

1. Each category is assigned a suitable and representative name that is reflective of that category and is concise.
2. A category description must provide a definition of the category, describing what the researcher means by the name given to describe the category, thereby demonstrating the applicability of the category and what characteristics represent this category;
3. Examples from the data are used to illustrate the category definition;
4. Decision rules ensure the mutual exclusivity of subcategories.

(Schreier, 2014)

Adherence to these four steps resulted in the creation the relevant categories (Appendix O).

iv. The final step of the coding frame is the revision and expanding of the frame, whereby the researcher reviews the coding frame – as indicated in the previous three steps – to ensure clarity and consistency, and the tying up of “loose ends” (Schreier, 2014). This may necessitate merging similar subcategories, promoting ‘larger’ subcategories into main categories, or creating further main categories or subcategories not considered during initial attempts to develop the coding frame. Overall, this is an iterative process of revising and amending the frame where necessary in order to fine tune its effectiveness.

d) Representing the data analysis involved representing findings that present the evidence to justify the themes or sub-themes that have emerged from the data, including citing specific quotes, as well as displaying findings through visual methods.

e) Interpreting the results involved examining how the findings addressed the research questions, making comparisons with the literature, and reflecting on the personal meaning of the findings. This step may also give rise to new questions (Creswell & Plano Clark, 2011: p. 205).

f) Validating the Data and Results involved checking that the information provided in the interview was accurate. In this regard, each transcript was emailed to the respective participant to be checked for accuracy. In order to check the coding used in the analysis of the interview transcripts, the researcher used an inter-coder reliability approach (Bazeley, 2017; Miles & Huberman, 1994). While the
intention of this approach is to add rigour to the qualitative analysis, Bazeley (2017) contends that this approach can be disputed, in that second and subsequent coders may not approach coding from the same perspective as the researcher – who has formulated the study – and may find it challenging to undertake the coding as the researcher might expect (Bazeley, 2017). While the researcher acknowledges the challenges outlined by Bazeley (2017), she opted to give two transcripts to a fellow Ph.D. student, and two additional transcripts to both of her supervisors to compare their coding with that of her own. The intention was to ascertain the reliability of the codes used in the transcripts by comparing the codes assigned within the transcripts (Creswell & Plano Clark, 2011). This exercise resulted in separate discussions about the coding approaches between the researcher and her fellow Ph.D. colleague, and with both supervisors. While it was not possible to give a precise percentage of similarity with the coding process, the researcher was satisfied that a high percentage of codes identified by the others were the same or synonymous with those of the researcher.

3.3.6 Step 6: Interpret how the Connected Results answer the Research Questions

Key Decision: Decide how the qualitative results explain the quantitative results.

In a sequential approach to mixed methods data analysis, both databases – quantitative and qualitative – are analysed separately at different stages, and are not merged (Creswell & Plano Clark, 2011). However, it is at the interpretation stage that the analysis of both sets of data is combined to answer the mixed methods question(s) with the intention of showing how the qualitative data help to elucidate the quantitative results (Creswell & Plano Clark, 2011).

As stated in section 3.1.3 the quantitative data collection and analysis preceded the qualitative phase; in this regard, the intention is that the qualitative data analysis will elucidate the scores from the MAS-UK test. Having analysed the quantitative data, the findings were sub-divided into the three factors of the MAS-UK scale. For each factor, the scores were categorised into different levels of mathematics anxiety – typically low, middle and high – using cluster analysis (Kaufmann & Rousseeuw, 2005; Tryfos, 1997), and this categorisation provided the basis for examination of the qualitative data in respect of what students with different levels of MA said about their engagement with mathematics in different situations aligning with Cemen’s (1987) Model of a
Mathematics Anxiety Reaction, thereby merging both sets of data and adhering to stage 6 of Creswell and Plano Clark’s (2011) framework (Table 3.1).

Each factor was analysed separately in respect of what the twenty students said in relation to situations of mathematics evaluation (Factor 1), everyday/social mathematics (Factor 2), and mathematics observation (Factor 3). This necessitated a review of the qualitative data analysis (Chapter 6) using keywords and synonyms relevant to the content of each factor. The list of relevant keywords and synonyms used to review the qualitative data stemmed from the description of each factor as provided by Hunt and colleagues (2011). These keywords and/or synonyms were identified within the NVIVO codebook (Appendix O) and quotations for each keyword were examined by reviewing the content of chapter 6. For example, for Factor 1 (mathematics evaluation anxiety) the following list of keywords (Table 3.4) was compiled and used to review chapter 6. References corresponding to these keywords were then categorised according to their alignment with the relevant aspect of Cemen’s (1987) Model of a Mathematics Anxiety Reaction.

| Table 3.4 Words used to Review Situations of Mathematics Evaluation |
|-----------------------|---------------|-------------|-------------|-------------|
| Algebra               | Divi+         | Learn off   | Pressure    | Support     |
| Answer                | Exam+         | Lecture+    | Problem     | Teacher     |
| Anxiety               | Father        | Memorise    | Public      | Test+       |
| Assess+               | Fraction      | Mother      | Question    | Tutor+      |
| Child+                | Hand+         | Multipl+    | Sibling     |             |
| Class                 | Kid           | Parent      | Stand       |             |

This approach facilitated the presentation and interpretation of findings in respect of significant environmental, dispositional and situational incidents for students with low, mid-range, and high levels of mathematics anxiety, and thereby allowing the researcher to address RQ2.

### 3.4 Reliability and Validity in Mixed Methods Research

Creswell and Plano Clark (2011) advocate the need for mixed methods researchers to consider issues pertaining to reliability and validity, acknowledging that each has different considerations for quantitative and qualitative research. For quantitative reliability the effectiveness of the instrument used to obtain test scores is important, and in this regard, the MAS-UK has been chosen for this study because of its suitability for
an adult population, and its excellent internal reliability (Cronbach’s alpha = 0.96) and test-retest reliability (r = 0.89) (Hunt, Clark-Carter and Sheffield, 2014); in the current study the Cronbach’s alpha score was α = 0.95. The significance of reliability to qualitative research lies in respect of inter-coder reliability (Bazeley, 2017) or inter-coder agreement (Miles & Huberman, 1994) whereby a number of persons engage in separately coding research transcripts and reach agreement on the codes used in the text (Creswell & Plano Clark, 2011). In the current study the inter-coder reliability process resulted in agreement among those engaged in the process of coding that a high percentage of codes applied to the transcripts were the same or synonymous.

While Creswell and Plano Clark (2011) acknowledge there are specific forms of validity for quantitative and qualitative research, they reflect the need to address validity in mixed methods research as it provides the researcher with a term recognisable to both quantitative and qualitative methods; in this regard, they advocate the use of validity in mixed methods research, which they define as ‘employing strategies that address potential issues in data collection, data analysis, and the interpretations that might compromise the merging or connecting of the quantitative and qualitative strands of the study and the conclusions drawn from the combination’ (Creswell & Plano Clark, 2011: p. 239). The authors outline potential threats to data collection, data analysis and interpretation, and corresponding strategies for minimising these threats. These potential threats to the current study are outlined below, as well as how they were addressed.

Data collection issues can arise with the selection of inappropriate individuals, and verifying accuracy of the information obtained; thus, ensuring that participants are chosen from the same population makes data comparable, and the member checking approach (Creswell & Plano Clark, 2011) asks participants to review their transcripts allowing for an accurate reflection of the findings (Creswell & Plano Clark, 2011); in respect of the current study the selection of the same mature students to participate in both phases of the study enabled the comparability of data. In addition, member checking was used, resulting in a number of transcripts being revised with minor changes. Further, a number of mature students submitted timelines of their experiences with mathematics, which added to the evidence to support their interview data.

Data analysis issues can arise where quantitative results by themselves do not lend themselves to explanation (Creswell & Plano Clark, 2011). In the current study, analysis
of the quantitative results presented different levels and factors of mathematics anxiety and needed to be further elaborated upon in order to address RQ2; in this regard, the subsequent qualitative analysis presented findings that formed the basis with which to facilitate interpretation of the combined findings – quantitative and qualitative - thereby addressing the need for the quantitative results to be further elucidated.

Interpretation issues include not addressing the mixed methods research question (Creswell & Plano Clark, 2011). In this regard, the current study utilised the quantitative scores from the MAS-UK to classify the mature students according to low, mid-range and high levels of mathematics anxiety, thereby providing the means to address RQ2, in addition the levels of mathematics anxiety were further elucidated using Cemen’s (1987) Model of a Mathematics Anxiety Reaction in order to identify those incidents that contributed to the level of MA experienced by the mature student. In this regard, the process reflected the aim of the interpretation stage of the study as building the qualitative data on the quantitative findings (Creswell & Plano Clark, 2011).

3.5 Ethical Considerations

Ethics are defined as “moral principles that govern a person’s behaviour or the conducting of an activity” (Stevenson, 2010). In the context of research activity, ethical issues need to guide the entire process of planning, conducting and using research (Mertens, 2015: p.347) and therefore need to be considered from the outset of the research study. Issues such as disclosing the purpose of the research, dealing with sensitive information, and the interchange of information underpin both quantitative and qualitative research (Creswell & Plano Clark, 2011). Of significance is the interactivity and relationship between the researcher and the research participant, together with the impact on the wider population (Denzin & Lincoln, 2013a). Being ethical involves the researcher being reflective and reflexive, demonstrating an openness towards the research participants’ views and insights and a willingness to learn from them, as well as with them (Lincoln et al., 2013; McNiff, 2013). By incorporating values such as integrity, empathy, respect, appreciation, with an open and flexible attitude, the researcher engages with the research participant by immersing themselves in the research setting, to make sense of and elucidate the narrative of the individual.

Before commencing the research process, the researcher applied for ethical approval (Appendix P) from the Faculty Sub-Committee of the University of Limerick Research
and Ethics Committee (hereafter ULREC). The application process acknowledged potential ethical issues and how they would be addressed, in particular that students’ participation was voluntary and they could withdraw at any time without implication; they would be provided in advance of participation with an information sheet and consent form; their data would be confidential, anonymised and stored as per ULREC guidelines; and their data would only be used for the purpose of this research project (SEREC, 2012). The application was granted after clarification had been given that the research participants were not students at my place of work, and that the audio files would be destroyed after transcription (Appendix Q). Two subsequent minor changes to the intended course of events led to renewed correspondence with the Ethics Committee (Appendix L and Appendix R) resulting in clarification of these two matters.

An ethical approach to research necessitates an openness with the research participants that ensures they are not deceived or objectified in any way (Denzin & Lincoln, 2013a); thus, the interactivity and relationship between the researcher and research participants, and with the wider population, is paramount (Denzin & Lincoln, 2013a). In this regard, the researcher sought and obtained permission from three of the four relevant HEI Mature Student Officers/Access Officers to attend the mature student induction day in order to address the students and present my research idea and information sheet. In the case of the fourth HEI, it was not possible to meet the students at induction due to time constraints in the schedule; however, the Access Officer kindly agreed to distribute my request to mature students via email correspondence. Subsequently all correspondence with mature students was via email or text message in order to facilitate completion of the questionnaire and to follow up with interested students who opted in to participate in phase two of the research process. The participants were aware from the outset that they had the right to withdraw from the study at any time and without reprimand. This included the right not to complete the online questionnaire and to have the recorder switched off at any stage during the interview at their request.

3.6 Summary

This chapter has presented the research design in respect of the current study, which identifies with the philosophy of pragmatism, adhering to a mixed methods strategy of inquiry and using both quantitative and qualitative methods to realise the aim of the research. The process of mixed methods research brings rigour and confidence to the representation of the topic of study. Similarly, the many viewpoints of the individual
research participants, as facilitated through the data collection, analysis and interpretation stages, while individually subjective they collectively provide the researcher with multiple, in-depth, rich, complex, yet complementary interpretations of the research topic.
Chapter 4 Quantitative Data Analysis
4.0 Introduction

The focus of this chapter is the analysis of the data collected through the administration of the questionnaire (Appendix E). Data was captured using Survey Monkey and Microsoft Excel, and subsequently uploaded to the Statistical Package for the Social Sciences (SPSS). Analysis was facilitated with the assistance of the SPSS program, versions 22 and 24 and – where relevant – Microsoft Excel 2013 and 2016. The sample size was N = 107, and descriptive statistics have been used to present the analysis, with a focus on median scores, as well as correlations, and other relevant tests to investigate the data set. The intention is that this chapter will provide a comprehensive quantitative analysis of the data set in order to address the demands of research question 1. To this end, section 4.1 looks at the analysis of the background information, followed by section 4.2 and the respondents’ programmes of study, engagement with mathematics before starting at the HEI, perceived ability in mathematics, and engagement with mathematics support at the HEI. Section 4.3 presents the findings in respect of the Mathematics Anxiety Scale – UK (MAS-UK) and its factors.

4.1 Background Information

This section looks at the findings for questions 1 to 5, namely:

1. Gender
2. Date of Birth
3. First language
4. What year the respondent left school
5. Name of current HEI

4.1.1 Gender of Respondents

Almost twice as many males (65.4%) as females completed the questionnaire (Table 4.1). More than twice as many IoT male students as female students responded, while this gap was narrower between Uni male and female students.

Table 4.1 Respondents by Sector and Gender

<table>
<thead>
<tr>
<th></th>
<th>M (N)</th>
<th>M (%)</th>
<th>F (N)</th>
<th>F (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IoT Sector</td>
<td>35.0</td>
<td>32.7</td>
<td>17.0</td>
<td>15.9</td>
</tr>
<tr>
<td>Uni Sector</td>
<td>35.0</td>
<td>32.7</td>
<td>20.0</td>
<td>18.7</td>
</tr>
<tr>
<td>Total</td>
<td>70.0</td>
<td>65.4</td>
<td>37.0</td>
<td>34.6</td>
</tr>
</tbody>
</table>
4.1.2 Date of Birth

As the survey targeted mature students, which required them to be aged 23 or above since January 1st 2015, this question was used to verify the student’s age, and therefore their status as a mature student. This verification was achieved by subtracting the date of birth from the date of completion of the questionnaire using MS Excel. Figure 4.1 shows the spread of ages of the respondents.

![Figure 4.1 Ages of the Respondents](image)

The respondents ranged in age from 24 to 50, with the median age being 31 years, 25% being 27 years or younger, and 75% of respondents being 38 years or younger. These findings are similar to the broader enrolment figures for mature students for that academic year (Table 2.3), with the median mature student enrolment age being in the high twenties. Figures 4.2(a) and 4.2(b) show the age categories of the respondents by HEI sector. In both sectors, the majority of respondents are aged 30 years and above.

---

11 A mature student in the Irish context is defined as a student who was 23 or over on the 1 January of the year of entry to the HEI (HEA, 2016: p. 23)

12 Median is used instead of mean as a measure of central tendency to allow for the presence of outliers and positive skew of the data set (Laerd Statistics, 2015).
4.1.3 First Language

The majority of respondents (83.2%) declared English as their first language. Of the remaining 16.8%, 4 respondents stated Polish, two Lithuanian, and one each stating Afrikaans, Galician, German, Latvian, Mende (Sierra Leone), Nepali, Portuguese, Romanian, Russian, Spanish, and Welsh. While all of the respondents are engaging with undergraduate programmes taught through English, there may be additional language challenges around the learning of service mathematics for those whose first language is not English.

4.1.4 Year left School

The year entered by the mature student was used to calculate how many years had passed from the time they had left school to the time of completion of the questionnaire. Using SPSS the year the student left school was subtracted from the year 2015, the year of completion of the questionnaire. The frequencies are displayed in Figure 4.3. The number of years since the respondents had been in school ranged from 4 years to 38 years (Median = 13). The data are positively skewed (0.825) with negative Kurtosis (-.340). A quarter of respondents had left school between four and eight years (25th percentile = 8), while 75% had left school between four and twenty years.
4.1.5 Respondents by HEI

The distribution of the respondents according to their current higher education institution of study is shown in Table 4.2.

Table 4.2 Survey Respondents by Higher Education Institution

<table>
<thead>
<tr>
<th>HEI</th>
<th>Total Mature Students Emailed N</th>
<th>Mature Students who Completed Questionnaires N</th>
<th>Mature Students who Completed Questionnaires %</th>
</tr>
</thead>
<tbody>
<tr>
<td>IoT 1</td>
<td>188</td>
<td>34</td>
<td>18.1</td>
</tr>
<tr>
<td>IoT 2</td>
<td>76</td>
<td>18</td>
<td>23.7</td>
</tr>
<tr>
<td>Uni 1</td>
<td>120</td>
<td>12</td>
<td>10.0</td>
</tr>
<tr>
<td>Uni 2</td>
<td>163</td>
<td>43</td>
<td>26.4</td>
</tr>
<tr>
<td></td>
<td>547</td>
<td>107</td>
<td>19.6</td>
</tr>
</tbody>
</table>

The respondents were almost equally divided between the two sectors, with 51.4% representing the university sector, and 48.6% the institute of technology sector. More than one quarter of the mature students targeted in Uni 2 completed the questionnaire, in contrast to a 10% completion rate in Uni 1. Comparatively, the completion rates among the two IoTs showed less of a variation.
4.2 Programme of Study

This section looks at the analysis of questions 6 to 9, namely:

6. What is the discipline of your programme of study at this HEI?
7. What level programme are you studying?
8. Is this programme full time/part time/other?
9. Does the programme have a mathematics module?

4.2.1 Discipline of Study

The respondents comprised students from a variety of disciplines (Table 4.3); however, there were large groups of respondents from the Science, Mathematics and Computing (40.2%), Engineering, Manufacturing and Construction (25.2%), and Social Sciences, Business and Law (18.7%) categories.

<table>
<thead>
<tr>
<th>Discipline of Study</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>4</td>
<td>3.7</td>
</tr>
<tr>
<td>Engineering, Manufacturing, Construction</td>
<td>27</td>
<td>25.2</td>
</tr>
<tr>
<td>Health and Welfare</td>
<td>7</td>
<td>6.5</td>
</tr>
<tr>
<td>Humanities and Arts</td>
<td>5</td>
<td>4.7</td>
</tr>
<tr>
<td>Science, Mathematics, Computing</td>
<td>43</td>
<td>40.2</td>
</tr>
<tr>
<td>Services</td>
<td>1</td>
<td>0.9</td>
</tr>
<tr>
<td>Social Sciences, Business, Law</td>
<td>20</td>
<td>18.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>107</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Further analysis of these figures presents the breakdown of discipline by gender of respondent (Figure 4.4). At this juncture, it is important to recall that the respondents comprise almost twice as many males as females (65.4% male, 34.6% female). The number of male respondents exceeds female respondents in all categories, except Health and Welfare, with 5 female respondents, and Services, with only one respondent – a female. Education shows an equal balance among male (N = 2) and female (N = 2) respondents.
The disciplines with the largest proportions of male respondents are Engineering, Manufacturing and Construction (N = 23), and Science, Mathematics and Computing (N = 29). By contrast, Social Sciences, Business and Law had eleven male respondents, and Humanities and Arts had three.

Figures 4.5(a) and 4.5(b) depict the contrasts between male and female respondents in respect of their discipline of study.

The largest proportion of both male and female respondents study Science, Mathematics and Computing (41.4% and 37.8% respectively). Almost three quarters of male respondents (74.3%) are enrolled in a programme of Science, Mathematics and
Computing or Engineering, Manufacturing and Construction. Adding Social Science, Business and Law to these represents 90% of male respondents. None of the male respondents is studying a Services programme. By contrast, over three quarters of female respondents (75.6%) study programmes in Science, Mathematics and Computing, Social Science, Business and Law, and Health and Welfare.

4.2.2 Level of Programme of Study

Table 4.4 shows the breakdown of respondents by level of programme.

<table>
<thead>
<tr>
<th>Programme Level</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 6</td>
<td>3</td>
<td>2.8</td>
</tr>
<tr>
<td>Level 7</td>
<td>22</td>
<td>20.6</td>
</tr>
<tr>
<td>Level 8</td>
<td>82</td>
<td>76.6</td>
</tr>
</tbody>
</table>

More than three quarters of respondents (76.6%) had enrolled in full-time Level 8 undergraduate programmes of study. These figures compare favourably with national enrolment figures in 2015/16 for each level, namely 6.3% at level 6, 14.6% at level 7, and 79.1% at level 8.

4.2.3 Mode of Programme Delivery

This question was included to confirm that respondents were full-time students at their designated HEI. All respondents declared they were full-time students.

4.2.4 Does the Programme have a Mathematics Module?

As mentioned in section 3.3.1 above, 49 respondents declared they did not have a service mathematics module, while 107 did.

4.2.5 Before you engaged with this Programme

This section looks at the findings for questions 10, 11 and 12, which asked respondents about their awareness of the mathematics content before they applied for the programme of study, as well as asking how – if at all – they updated their mathematics knowledge before commencing the programme.

Question 10: Before you applied for this programme, were you aware that the programme had a mathematics module?
This was a Yes/No question. A majority of 86% of respondents were aware that their chosen programme of study had a mathematics module prior to applying for the programme, while 14% were unaware.

**Question 11: Before starting this programme, did you update your mathematics knowledge?**

This was also a Yes/No question. Just over half of respondents (52.3%, N = 56) updated their mathematics knowledge before commencing their programme of study. For this question, where respondents answered yes, by way of the Survey Monkey facility called ‘Page Skip Logic’ they were directed to answer question 12 (the following question). In a similar way, if they answered no, the next option for those respondents was to continue to question 13.

**Question 12: How did you update your mathematics knowledge? (Please tick all that apply)**

This was a multiple-choice question where respondents could tick all that applied. There were four defined options, and an ‘Other (please specify)’ option where respondents could type their answers:

- I attended a preparatory mathematics programme at this HEI
- I attended a preparatory mathematics programme at another HEI
- I obtained private tuition/grinds in mathematics
- I engaged in self-study of mathematics
- Other (please specify)

There were 18 responses to the ‘Other, please specify’ option, of which 6 referred to doing a mathematics course at the HEI, and 5 referred to doing a mathematics course at another HEI. This suggested that the wording of the original question and/or options was not clear to all respondents. Adding these answers to their respective totals, 50% had attended a preparatory mathematics programme at their current HEI; 14.3% had attended a preparatory mathematics programme at another HEI; 7.1% obtained private tuition/grinds in mathematics, and 37.5% engaged in self-study of mathematics. The remaining answers included reference to doing a FETAC level 5 or 6 course (3 respondents), as well as doing Leaving Certificate mathematics at higher level (4 respondents), with one respondent having done both higher level Leaving Certificate mathematics and a FETAC level 6 course. Eleven respondents ticked more than one option; of these, eight respondents chose two options with seven of these being both
attendance at a preparatory mathematics programme at this HEI and engagement in self-study of mathematics. The remaining three respondents chose three options, of which each had ‘attended a preparatory mathematics programme at this HEI’, along with varying combinations of the other options.

4.2.6 Other Programmes of Study completed

This section comprised questions 13 and 14. The intention with these questions was partly to gain an insight into whether this was their first time re-engageing with education since leaving school; but also to ascertain if they had come across mathematics in that programme and how they had felt about the mathematics they encountered.

Question 13: Have you completed any other programme of study since you left school?

This was a Yes/No question, and almost two-thirds of respondents (64.5%, N = 69) had completed another programme of study since leaving school. If respondents answered Yes, they were directed to question 14 (by way of Survey Monkey’s Page Skip Logic), otherwise they were directed to the next section of the questionnaire.

Question 14: How did you feel about the mathematics in that programme (if applicable)?

Of those that had completed another programme, 71% (N = 49) responded to how they felt about mathematics in that programme. Where respondents had indicated that mathematics did not feature in their programme these were disregarded for question 14. Responses were analysed in terms of positive and negative responses, as well as contrasting responses or responses where there was a transition in feeling towards mathematics. Table 4.5 presents the findings. The feelings expressed comprise a variety of feelings about the mathematics experienced by the respondents during a programme of study completed since leaving school and before enrolling at their current HEI; these can be categorised as positive and negative feelings, as well as feelings demonstrating a contrast or transition in feeling towards mathematics.
<table>
<thead>
<tr>
<th>Positive</th>
<th>Contrasting</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>• No issue with the maths, was basic leaving cert honours and a bit more.</td>
<td>• It is more advanced, and as science mathematics which is about words problem gave me tough time a while before I got used to it.</td>
<td>• Anxious, out of depth</td>
</tr>
<tr>
<td>• OK</td>
<td>• Reasonably happy. It’s moving very fast but is manageable.</td>
<td>• Anxious that I wouldn't meet the standard of maths required.</td>
</tr>
<tr>
<td>• It was the leaving cert pass level and it was not difficult.</td>
<td>• It was hard but plenty of study and I passed</td>
<td>• Level 3 mathematics terrified me</td>
</tr>
<tr>
<td>• It's basic</td>
<td>• Tough but doable</td>
<td>• I was very insecure</td>
</tr>
<tr>
<td>• It is suitable to my course</td>
<td>• Hard work to begin with then got slowly better</td>
<td>• I'm not great at maths so a bit apprehensive</td>
</tr>
<tr>
<td>• Enjoyable challenge and rewarding</td>
<td>• Challenging but ok once effort was put in</td>
<td>• Time consuming, stressful and all consuming</td>
</tr>
<tr>
<td>• It was refreshing at the time and very helpful and gained much.</td>
<td>• Basic ordinary level leaving cert maths was covered on this programme at a slow pace with a small class size of 10 students, compared to first year science or engineering maths class sizes of 450+ students at a fast pace.</td>
<td>• I find it quite difficult</td>
</tr>
<tr>
<td>• Comfortable due to a good mathematical ability and good results in maths in the leaving certificate</td>
<td>• At first very nervous but throughout the year my confidence increased.</td>
<td>• I found maths very difficult in any of my subjects.</td>
</tr>
<tr>
<td>• Repeat LC doing OL Mathematics. I found it very straightforward and comfortably gained an A1 grade.</td>
<td>• Challenging but very important, useful</td>
<td>• I deferred my place as my Maths is not up to standard, I got a reasonable result in school. O B3 but I do not have the extra time to put into studying chemistry and physics as well as the Maths I have forgotten over 20 years</td>
</tr>
<tr>
<td>• The maths was basic and it was just related to what we would use in the workshop and a bit for pricing a job.</td>
<td>• Daunting at first and a bit worried, but was very determined.</td>
<td>• I don't think there's a need for it as I will never use it in the future</td>
</tr>
<tr>
<td>• Loved it</td>
<td>• I have a love/hate relationship with Maths. When it goes good I love maths but when I encounter problems I hate Maths.</td>
<td>• I didn't enjoy it and didn’t put in effort.</td>
</tr>
<tr>
<td>• Relaxed and comfortable</td>
<td></td>
<td>• I knew I would struggle with it</td>
</tr>
<tr>
<td>• Great. I had excellent results. I like to study maths even further.</td>
<td></td>
<td>• Found it hard</td>
</tr>
<tr>
<td>• I will study statistics later during my career.</td>
<td></td>
<td>• Tough</td>
</tr>
<tr>
<td>• I found it a lot easier than in secondary school</td>
<td></td>
<td>• It's difficult</td>
</tr>
<tr>
<td>• 1992 was a long time ago... I was fresh from ordinary level leaving cert maths... it was ok</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• I found the mature students preparatory course very useful</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• I have always been ok with maths, it just came naturally to me</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Easy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Enjoyable and practical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Good way to refresh my maths knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• I love mathematics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Good</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Positive feelings are characterised in terms of four themes: relevance of mathematics; enjoyment of mathematics; comfort with mathematics; competence in mathematics. Negative feelings comprise feelings about how they perceived the mathematics: stressful, time consuming, difficult, tough, hard; and feelings they themselves had when doing – or anticipating doing – mathematics: not great, anxious, terrified, insecure, apprehensive, out of depth, not up to standard. In between these extremities were responses that illustrated a contrast or transition from one feeling about mathematics to a different way of feeling; for example, where mathematics was difficult or fast paced at first, but with time, effort, and hard work things improved; daunting to determined; nervousness to confidence; seeing the relevance and importance of mathematics over time.

4.2.7 Rating of Ability with Mathematics at different Time Periods

This section asked respondents to indicate how they perceived their ability in mathematics at four different periods of their lives.

Question 15: On a scale of 1 to 10 (1=lowest, 10=highest) how would you rate your ability in mathematics

This question provided respondents with a table, whereby they would rate their ability in mathematics at primary school, secondary school, since leaving school, and today using a Likert scale ranging from 1 (the lowest ability) to 10 (the highest ability). Respondents could only choose one rating for each time period, and this was facilitated by Survey Monkey through the use of Radio Buttons, which only allow one choice for each statement. Figure 4.6 shows the outcome. Respondents expressed higher ratings of perceived ability in mathematics at primary level (Median = 8), followed by second level (Median = 7). Ratings of ability today (Median = 6) showed perceived improvements since leaving school (Median = 5). Rating of perceived ability since leaving school was lower than for the other periods of time. While each graph is negatively skewed, the extent of this is most pronounced for rating of ability at primary level (Skewness = -0.771).
Figure 4.6 Respondents’ Rating of Ability in Mathematics at Primary School, Secondary School, Since Leaving School, and Today

4.2.8 Mathematics Support at this HEI

This section comprises questions 16 and 17 and asks respondents if they are aware of mathematics support at the HEI, and of their intention to use it.

Question 16: Are you aware of the mathematics support service at this HEI?

This was a YES/No question. Over three quarters (76.6%) were aware of the mathematics support service at their HEI; however, 23.6% were not. Table 4.6 shows the findings by HEI.

<table>
<thead>
<tr>
<th>% aware within HEI</th>
<th>IoT 1</th>
<th>IoT 2</th>
<th>Uni 1</th>
<th>Uni 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>84.8%</td>
<td>42.1%</td>
<td>83.3%</td>
<td>83.7%</td>
<td></td>
</tr>
<tr>
<td>15.2%</td>
<td>57.9%</td>
<td>16.7%</td>
<td>16.3%</td>
<td></td>
</tr>
</tbody>
</table>
Of the four HEIs, IoT1 showed the highest awareness among its respondents (84.8%), followed closely by Uni2 (83.7%) and Uni1 (83.3%). In contrast, IoT2 is the only HEI where more respondents are not aware (57.9%) than aware of mathematics support.

**Question 17: Do you intend using the mathematics support service at this HEI?**

This question gave respondents three options: Yes, No, and Don’t know. More than three-fifths of respondents (60.7%) expressed their intention to use the mathematics support service at their HEI, while 13.1% were not intending to use the service. Over one quarter of respondents (26.2%) did not know. These figures were further analysed by individual HEI (Table 4.7).

<table>
<thead>
<tr>
<th>HEI</th>
<th>Yes N</th>
<th>Yes %</th>
<th>No N</th>
<th>No %</th>
<th>Don’t Know N</th>
<th>Don’t Know %</th>
<th>Total N</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>IoT1</td>
<td>21</td>
<td>64%</td>
<td>4</td>
<td>12%</td>
<td>8</td>
<td>24%</td>
<td>33</td>
<td>94%</td>
</tr>
<tr>
<td>IoT2</td>
<td>8</td>
<td>42%</td>
<td>4</td>
<td>21%</td>
<td>7</td>
<td>37%</td>
<td>19</td>
<td>46%</td>
</tr>
<tr>
<td>Uni1</td>
<td>7</td>
<td>58%</td>
<td>0</td>
<td>0%</td>
<td>5</td>
<td>42%</td>
<td>12</td>
<td>26%</td>
</tr>
<tr>
<td>Uni2</td>
<td>29</td>
<td>67%</td>
<td>6</td>
<td>14%</td>
<td>8</td>
<td>19%</td>
<td>43</td>
<td>95%</td>
</tr>
</tbody>
</table>

The highest proportions of respondents from IoT1 (64%) and Uni2 (67%) intend using the mathematics support service at those HEIs. In contrast the highest proportions of those who do not know are from IoT2 (37%) and Uni1 (42%). IoT2 also has the highest proportion of those respondents who do not intend using the service (21%).

**4.2.9 Mathematics in your future Career**

This section wanted to ascertain if the respondents believed that mathematics would feature in their future careers and comprised question 18.

**Question 18: Do you envisage that your future career will involve mathematics?**

The possible responses were Yes, No, and Don’t know. More than three quarters (77.6%) affirmed that their future career would involve mathematics, while 12.1% chose No, and 10.3% didn’t know.

**4.2.10 Respondents’ Feelings about Mathematics at Time of Completion of the Questionnaire**

This section posed one question, question 19.
Question 19: On a scale of 1 to 10 (1= Not anxious, 10 = Extremely anxious) how do you feel about mathematics right now?

This question asked after the level of anxiety the respondents were feeling at the time of completion of the questionnaire, using a Likert scale to indicate responses, ranging from 1 (not anxious) to 10 (extremely anxious). In contrast to the measurement of mathematics anxiety using a lengthier scale, such as the MAS-UK with 23 items, research by Núñez-Peña, Guilera and Suárez-Pellicioni (2014) has tested the use of a single-item mathematics anxiety scale (SIMA scale) to ascertain a person’s level of mathematics anxiety. Thus, this question aimed to examine this approach to testing for mathematics anxiety among the current cohort and compare the findings against the MAS-UK scores obtained. Correlation between the findings of this question and the respondents’ MAS-UK scores showed a significant positive relationship between the two scales (r = 0.6, P < 0.001).

4.2.11 Mathematics Anxiety Scale-UK Scale

The final section of the questionnaire comprised the MAS-UK scale, question 20. Respondents were given instructions about this section:

For each of the 23 statements listed below, please show how you feel about each of the statements right now (rather than in the past, for example) by selecting one of the options provided. The options range from 'not at all' to 'very much'.

Please answer all 23 statements.

Question 20: How anxious would you feel in the following situations right now?

The MAS-UK scale can realise a score somewhere between a minimum score of 23 and a maximum of 115 (Hunt et al., 2011). The scores in the current sample ranged from the lowest possible score of 23 up to 94. The MAS-UK data were tested for normality using the Shapiro-Wilk test\(^{13}\) which returned a p-value of < 0.001, indicating the data are not normally distributed. Figure 4.7 shows the data is positively skewed, with a median value of 43, and no outliers (Field, 2013). While the MAS-UK test has the potential to yield scores ranging from the lowest mathematics anxiety score of 23 to the highest score of 115, respondents in the current study yielded scores ranging from 23 to 94.

\(^{13}\) The Shapiro-Wilk test is used to test if the distribution of scores is significantly different from a Normal Distribution (Field, 2013).
Figure 4.7 MAS-UK Scores of Respondents (N = 107)

Figure 4.8 shows the distribution of these scores; the x-axis demonstrates the possible scope of the MAS-UK scale (i.e. minimum of 23 to maximum of 115).

Figure 4.8 MAS-UK Scores of Respondents

The chart depicts an obvious gap in the range of scores between 73 and 82. The median score of the entire sample is 43.
4.3 Further Analysis of the MAS-UK Scores

In line with other studies, the MAS-UK scores were analysed to ascertain if there were links or correlations between the respondent’s score and other variables in the questionnaire; namely gender, age, first language, HEI, discipline of study, years since leaving school, feelings about mathematics in another programme of study, and rating of ability in mathematics. These findings are presented here.

4.3.1 Gender and MAS-UK Score

Female respondents report slightly higher MAS-UK scores than males. The median scores for male and female respondents are 42 and 51 respectively. The interquartile ranges are 27 (Males) and 31.5 (Females), as illustrated in Figure 4.9.

![Figure 4.9 Comparison of MAS-UK Scores among Male and Female respondents](image)

Additional analysis of the respondents’ MAS-UK scores and Gender was done using a Mann Whitney test\(^\text{14}\) to compare MAS-UK scores in male respondents with MAS-UK scores in female respondents. The test revealed that there was no significant difference

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\(^{14}\) The Mann Whitney test is a non-parametric test that checks for differences between two independent samples (Field, 2013).
between the male MAS-UK scores and the female MAS-UK scores ($U = 1003.5$, $p = 0.056$).

4.3.2 Age and MAS-UK Score

There is a very weak negative correlation between the respondents’ Age and MAS-UK score ($r = -0.014$).

4.3.3 Age and Rating of Ability in Mathematics

There is a very weak, negative correlation between the respondents’ Age and Rating of Ability ($r = -0.047$).

4.3.4 First Language and MAS-UK Score

The median MAS-UK score is higher for respondents whose first language is English (45) compared with respondents whose first language is not English (38).

4.3.5 Years since leaving School and MAS-UK Score

There was no correlation between the number of years since the respondents left school and their MAS-UK scores ($r < 0.001$). In order to further probe if there was any relationship between the number of years since leaving school and particular statements within the MAS-UK scale, the researcher tested the data for correlation between the number of years since the respondent left school and each statement on the MAS-UK test. This act resulted in three significant findings:

Statement 3: Being asked to write an answer on the board at the front of a maths class

$r = -0.216$ (significant at 0.05 level – two tailed) suggesting the longer the number of years since the respondent has left school, the less anxious they are about doing this.

Statement 9: Reading the word ‘algebra’

$r = 0.266$ ($p < 0.05$) suggesting the longer the number of years since the respondent has left school, the more anxious they are about reading the word algebra.

Statement 16: Watching someone work out an algebra problem

$r = 0.213$ ($p < 0.05$) suggesting the longer the number of years since the respondent has left school, the more anxious they are about watching someone work out an algebra problem.
4.3.6 Years since leaving School and Rating of Ability in Mathematics

In order to check if there was any correlation between the number of years the student had left school and the rating of ability in mathematics ‘today’ the data were subjected to further analysis. Correlation between the number of years since leaving school and how they rate their ability in mathematics today is very weak and negative (r = -0.057).

4.3.7 HEI and MAS-UK Score

The collective HEI scores showed a median of 48 for IoTs and 41 for Unis. The median scores among respondents by HEI showed higher levels of mathematics anxiety among IoT students than Uni students (Table 4.8).

<table>
<thead>
<tr>
<th>Table 4.8 Median MAS-UK Scores of Respondents by HEI</th>
</tr>
</thead>
<tbody>
<tr>
<td>IoT1</td>
</tr>
<tr>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Median MAS-UK Score</td>
</tr>
<tr>
<td>Frequency (N)</td>
</tr>
</tbody>
</table>

While these findings would suggest that IoT respondents demonstrate more mathematics anxiety than Uni respondents, they also imply that there is similarity among the two Unis and disparity among the two IoTs. Further, it is worth acknowledging that the frequencies for the four HEIs differ considerably from each other. Cross-referencing the HEI and MAS-UK scores with gender shows that male Uni respondents demonstrate a lower median score of 38, compared with females with 41. In the IoT sector, male respondents had a median score of 45, and females a median score of 56.

Additional analysis of the respondents’ MAS-UK scores and their HEIs was done using two further tests; a Mann Whitney U Test to compare MAS-UK scores among IoT respondents (N = 52) and Uni respondents (N = 55), and a Kruskal-Wallis (KWH) test15 to compare scores across the four individual HEIs. The Mann Whitney U test revealed that there was no significant difference between the IoT respondents’ MAS-UK scores and the Uni respondents’ MAS-UK scores (U = 1221.5, p = 0.194). Similarly, the KWH test showed that there was no statistically significant difference in MAS-UK scores between students studying at each of the four HEIs ($\chi^2(3) = 3.514, p = 0.319$).

15 The Kruskal-Wallis test is a non-parametric test that can be used to determine whether there are differences between two or more independent groups (Field, 2013).
4.3.8 Discipline of Study by MAS-UK Score

In order to ascertain if there was a particular discipline of study that was susceptible to higher or lower MAS-UK scores, the respondents’ MAS-UK scores were cross-referenced with their chosen disciplines of study. Figure 4.10 shows the disciplines of study in order of increasing median MAS-UK scores. There was one respondent studying a Services programme who had a low MAS-UK score of 31. Otherwise, respondents studying programmes in Social Science, Business and Law had the lowest median MAS-UK score (38, N = 20); this was followed by Engineering, Manufacturing and Construction (41, N = 26) and Science, Mathematics and Computing (43, N = 43).

Respondents studying programmes in Humanities and Arts had the highest median MAS-UK score, but the sample size was small (83, N = 5), followed by Health and Welfare (66, N = 7) and Education (59, N = 4). Further, a Kruskal-Wallis H test showed that there was a statistically significant difference in MAS-UK scores between students studying in the different disciplines ($\chi^2(6) = 13.892, p = 0.031$), with a post test analysis reflecting the levels of anxiety as presented in Figure 4.10.
4.3.9 Level of Programme and MAS-UK Score

The MAS-UK score by Level of Programme shows a considerable difference in median values between Level 6, Level 7 and Level 8 programmes (Table 4.9). It is noteworthy to acknowledge that the sample sizes differed considerably. With only three respondents, level 6 showed the highest median MAS-UK score; however, one Level 6 respondent had a very low MAS-UK score of 27. Level 7 respondents had the highest range of scores and showed a median MAS-UK score of 56, while Level 8 respondents comprised the majority of respondents and had a median MAS-UK score of 42.

<table>
<thead>
<tr>
<th></th>
<th>Level 6</th>
<th>Level 7</th>
<th>Level 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondents (N)</td>
<td>3</td>
<td>22</td>
<td>82</td>
</tr>
<tr>
<td>Median MAS-UK score</td>
<td>62</td>
<td>56</td>
<td>42</td>
</tr>
<tr>
<td>Range</td>
<td>27 to 73</td>
<td>26 to 94</td>
<td>23 to 88</td>
</tr>
</tbody>
</table>

4.3.10 Awareness of Mathematics Module before starting Programme and MAS-UK Score

Comparing the MAS-UK scores of those respondents who were aware (N = 92) there was a mathematics module in their programme of study before applying for the programme, with those who were not aware (N = 15) shows a considerable difference in median scores; aware with median = 40, not aware with median = 62. Further investigation into the ‘not aware’ respondents found that 14 of the 15 have English as a first language, so lack of knowledge about the programme having a mathematics module is not due to potential language difficulties.

4.3.11 Effect of Respondents updating their Mathematics Knowledge and MAS-UK Score

More than half of respondents (N = 56, 52%) had updated their knowledge of mathematics before starting at the HEI. Taking the MAS-UK scores of the Yes respondents – those who did update their mathematics knowledge – and comparing with the No respondents – those who did not – shows noted differences in the median MAS-UK scores, with 43 and 48 respectively. While the skew of data is positive for both groups of respondents – with 0.62 for Yes respondents, and 0.51 for No respondents – the MAS-UK scores of Yes respondents are more positively skewed than those of No respondents, suggesting that the additional preparation in mathematics before commencing the programme of study likely
resulted in the Yes respondents being less mathematics anxious than the No respondents. Further analysis of the methods used to update the students’ knowledge of mathematics was conducted using a Kruskal Wallis H test and indicated the distribution of MAS-UK scores is the same across methods ($\chi^2(10) = 8.783$, $p = 0.553$).

**4.3.12 Other Programmes of Study Completed and MAS-UK Score**

Almost two thirds of respondents ($N = 69$, 64.5%) had completed another programme of study since leaving school. For the respondents who had completed another programme, the median MAS-UK score was higher: Median = 45 compared with Median = 42 for those who had not. Further analysis of this data cross-referenced with the data on whether they had updated their mathematics knowledge before starting at their current HEI is depicted in Table 4.10.

<table>
<thead>
<tr>
<th>Other Programme Completed</th>
<th>Updated Mathematics Knowledge</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes (Median MAS-UK score)</td>
<td>No (Median MAS-UK score)</td>
</tr>
<tr>
<td></td>
<td>38 (45)</td>
<td>31 (53)</td>
</tr>
<tr>
<td></td>
<td>18 (39.5)</td>
<td>20 (42.5)</td>
</tr>
</tbody>
</table>

A majority of participants (35.5%, $N = 38$) had completed another programme of study and had updated their mathematics knowledge before starting at their current HEI; in addition, the median MAS-UK score for this cohort was 45, suggesting a slight amount of anxiety towards mathematics. By contrast 29% ($N = 31$) had completed another programme but had not updated their mathematics knowledge; the median MAS-UK score was 53. This suggests that not updating their mathematics knowledge may have contributed to that median level of anxiety. By contrast, those who had not completed another programme of study have lower median MAS-UK scores, with the lowest (median MAS-UK = 39.5) referring to the students not having completed another programme of study but having updated their mathematics knowledge before starting at the HEI.
4.3.13 Feelings about Mathematics in another Programme of Study and MAS-UK Score

Table 4.11 builds on Table 4.5 by including the MAS-UK scores for each participant who wrote that statement.
Table 4.11 How Respondents felt about Mathematics in another Programme of Study and corresponding MAS-UK Scores

<table>
<thead>
<tr>
<th>How did you feel about the mathematics?</th>
<th>MAS-UK Score</th>
<th>How did you feel about the mathematics?</th>
<th>MAS-UK Score</th>
<th>How did you feel about the mathematics?</th>
<th>MAS-UK Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td></td>
<td>Contrast/ Transition</td>
<td></td>
<td>Negative</td>
<td></td>
</tr>
<tr>
<td>Great. I had excellent results. I like to study maths even further. I will study statistics later during my career.</td>
<td>24</td>
<td>Tough but doable</td>
<td>24</td>
<td>Tough</td>
<td>25</td>
</tr>
<tr>
<td>I have always been ok with maths, it just came naturally to me</td>
<td>25</td>
<td>Basic ordinary level LC maths was covered on this programme at a slow pace with a small class size of 10 students, compared to first year science or engineering maths class sizes of 450+ students at a fast pace.</td>
<td>26</td>
<td>Anxious that I wouldn't meet the standard of maths required.</td>
<td>37</td>
</tr>
<tr>
<td>It is suitable to my course</td>
<td>26</td>
<td></td>
<td></td>
<td>Anxious, out of depth</td>
<td>45</td>
</tr>
<tr>
<td>Relaxed and comfortable</td>
<td>26</td>
<td></td>
<td></td>
<td>Found it hard</td>
<td>47</td>
</tr>
<tr>
<td>I found the mature students preparatory course very useful</td>
<td>28</td>
<td>Challenging but very important, useful</td>
<td></td>
<td>It's difficult</td>
<td>48</td>
</tr>
<tr>
<td>It was the leaving cert pass level and it was not difficult.</td>
<td>28</td>
<td>Challenging but ok once effort was put in</td>
<td>31</td>
<td>I knew I would struggle with it</td>
<td>53</td>
</tr>
<tr>
<td>No issue with the maths, was basic LC honours and a bit more.</td>
<td>28</td>
<td>It is more advanced, and as science mathematics which is about words problem gave me tough time a while before I got used to it.</td>
<td>33</td>
<td>Time consuming, stressful and all consuming</td>
<td>56</td>
</tr>
<tr>
<td>Good way to refresh my maths knowledge</td>
<td>29</td>
<td></td>
<td></td>
<td>I find it quite difficult</td>
<td>58</td>
</tr>
<tr>
<td>Enjoyable and practical</td>
<td>31</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I love mathematics</td>
<td>31</td>
<td>I have a love/hate relationship with Maths. When it goes good I love maths but when I encounter problems I hate Maths.</td>
<td>37</td>
<td>Level 3 mathematics terrified me</td>
<td>59</td>
</tr>
<tr>
<td>Loved it</td>
<td>33</td>
<td></td>
<td></td>
<td>I'm not great at maths so a bit apprehensive</td>
<td>66</td>
</tr>
<tr>
<td>1992 was a long time ago... I was fresh from ordinary level leaving cert maths... it was ok.</td>
<td>34</td>
<td></td>
<td></td>
<td>I didn't enjoy it and didn’t put in effort.</td>
<td>67</td>
</tr>
<tr>
<td>Enjoyable challenge and rewarding</td>
<td>37</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repeat LC doing OL Mathematics. I found it very straightforward and comfortably gained an A1 grade.</td>
<td>37</td>
<td>Daunting at first, a bit worried, but was very determined.</td>
<td>41</td>
<td>I don’t think there’s a need for it as I will never use it in the future</td>
<td>83</td>
</tr>
<tr>
<td>OK</td>
<td>37</td>
<td>It was hard but plenty of study and I passed</td>
<td>48</td>
<td>I was very insecure</td>
<td>85</td>
</tr>
<tr>
<td>Comfortable due to a good mathematical ability and good results in maths in the leaving certificate</td>
<td>38</td>
<td>Reasonably happy. It's moving very fast but is manageable.</td>
<td>56</td>
<td>I have deferred my place as my Maths is not up to standard, I did get a reasonable result in school. O b3 but I do not have the extra time to put into studying chemistry and physics as well as the Maths I have forgotten over 20 years</td>
<td>86</td>
</tr>
<tr>
<td>It's basic</td>
<td>38</td>
<td>At first very nervous but throughout the year my confidence increased.</td>
<td>57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>It was refreshing at the time and very helpful and gained much.</td>
<td>42</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easy</td>
<td>45</td>
<td>Hard work to begin with then got slowly better</td>
<td>73</td>
<td>I found maths very difficult in any of my subjects.</td>
<td>94</td>
</tr>
<tr>
<td>Good</td>
<td>51</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The maths was basic and it was just related to what we would use in the workshop and a bit for pricing a job.</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I found it a lot easier than in secondary school</td>
<td>65</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ok</td>
<td>67</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The MAS-UK scores for the positive comments range from a low of 24 to 67, with a low median score of 34. The median MAS-UK score for the contrast/transition comments is slightly higher at 37, with a range of scores from 24 to 73. However, the negative comments have a range of 25 to 94, and a median score of 58, demonstrating a higher level of anxiety among these respondents.

4.3.14 Rating of Ability in Mathematics and MAS-UK Score

There is a significant negative correlation between the MAS-UK scores and ratings of ability in primary school (r = -0.423, p < 0.01), in secondary school (r = -0.418, p < 0.01), since leaving school (r = -0.474, p < 0.01), and today (r = -0.652, p < 0.01). While ability in mathematics ‘today’, i.e. at the time of completion of the questionnaire, was addressed by cross-referencing the ratings with other variables (sections 4.3.3 and 4.3.6), this section looks at ability ‘today’ and corresponding MAS-UK scores of the respondents. There is a significant negative correlation among the respondents’ rating of their ability in mathematics at the time of completion of the questionnaire and their MAS-UK scores (r = -0.652, p < 0.01), suggesting the higher their perceived rating of ability in mathematics, the lower the respondents’ MAS-UK score, and vice versa.

4.3.15 Awareness of Mathematics Support and MAS-UK Score

There is a considerable difference between the median MAS-UK scores of respondents who are aware about the mathematics support service at the HEI and those who are not: Median = 40.5 compared with Median = 53. This suggests respondents who are aware of mathematics support are less mathematics anxious than those who are not aware. Table 4.12 shows the breakdown of these figures according to HEI sector.

Table 4.12 Awareness of Mathematics Support, Median MAS-UK Score and Number of Respondents

<table>
<thead>
<tr>
<th>IoT</th>
<th>Uni</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aware</td>
<td>Not Aware</td>
</tr>
<tr>
<td>Median MAS-UK score</td>
<td>Aware</td>
</tr>
<tr>
<td>IoT</td>
<td>Uni</td>
</tr>
<tr>
<td>Median MAS-UK score</td>
<td>44</td>
</tr>
<tr>
<td>N</td>
<td>36</td>
</tr>
</tbody>
</table>

IoT respondents who are aware of mathematics support have a median MAS-UK score of 44, and Uni respondents have a median MAS-UK score of 39. By contrast IoT respondents who are not aware have a median MAS-UK score of 53, while the median MAS-UK score of Uni respondents is 57. Further analysis of these scores by individual
HEI, showing the median MAS-UK scores and number of respondents, is shown in Table 4.13.

Table 4.13 Median MAS-UK Scores and Number of Respondents who were aware and were not aware of Mathematics Support by individual HEI

<table>
<thead>
<tr>
<th></th>
<th>Aware (median MAS-UK score)</th>
<th>N</th>
<th>Not Aware (median MAS-UK score)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>IoT 1</td>
<td>45</td>
<td>28</td>
<td>48</td>
<td>5</td>
</tr>
<tr>
<td>IoT 2</td>
<td>41</td>
<td>8</td>
<td>66</td>
<td>11</td>
</tr>
<tr>
<td>Uni 1</td>
<td>39</td>
<td>10</td>
<td>46</td>
<td>2</td>
</tr>
<tr>
<td>Uni 2</td>
<td>39</td>
<td>36</td>
<td>61</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td><strong>82</strong></td>
<td></td>
<td>Total</td>
<td><strong>25</strong></td>
</tr>
</tbody>
</table>

The range of values among the lowest and highest median MAS-UK scores of respondents who are aware is small (Range = 6) compared with that of the respondents who are not aware of mathematics support (Range = 20). Among those who are not aware of mathematics support, IoT2 respondents comprised the largest number and scored the highest median MAS-UK score, suggesting IoT2 respondents are not as well informed about the mathematics support service at that institution compared to the other respondents.

4.3.16 Intention to use Mathematics Support and Median MAS-UK Score

The declared intention of respondents to engage with the mathematics support service at the HEI was cross-referenced with the median MAS-UK scores. Those respondents who intend using the service (Yes) have a median MAS-UK score of 45, compared with the ‘No’ respondents with a low median score of 33, and the ‘Don’t Know’ respondents with 43. The figures are further analysed by HEI (Table 4.14).

Table 4.14 Intention to use Mathematics Support and Median MAS-UK Score

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Don’t Know</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median MAS-UK Score</td>
<td>N</td>
<td>Median MAS-UK Score</td>
</tr>
<tr>
<td>IoT1</td>
<td>56</td>
<td>21</td>
<td>31</td>
</tr>
<tr>
<td>IoT2</td>
<td>68</td>
<td>8</td>
<td>30.5</td>
</tr>
<tr>
<td>Uni1</td>
<td>38</td>
<td>7</td>
<td>No replies</td>
</tr>
<tr>
<td>Uni2</td>
<td>38</td>
<td>29</td>
<td>57.5</td>
</tr>
</tbody>
</table>

Among those respondents who intend using the mathematics support service, there is a considerable difference in median MAS-UK score among the four HEIs, with respondents in both Unis having relatively low scores (38) and those in IoT2 having the highest score
IoT2 also has the highest median MAS-UK score among those respondents who do not know if they intend to use the service (66). By contrast, both IoT1 and IoT2 respondents who do not intend using the service have low median MAS-UK scores (31 and 30.5 respectively), while the Uni2 respondents’ median score was considerably higher (57.5). This suggests a lower level of anxiety towards mathematics among those IoT respondents compared with the corresponding Uni2 respondents.

The figures were also cross-referenced with those from the awareness of mathematics support findings (Table 4.15).

**Table 4.15 Awareness of and Intention to use Mathematics Support Service with Median MAS-UK Score**

<table>
<thead>
<tr>
<th>Aware</th>
<th>Intend</th>
<th>Median MAS-UK Score</th>
<th>N</th>
<th>Median MAS-UK Score</th>
<th>N</th>
<th>Median MAS-UK Score</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td>42</td>
<td>57</td>
<td>31</td>
<td>11</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
<td>61.5</td>
<td>8</td>
<td>38</td>
<td>3</td>
<td>55</td>
</tr>
<tr>
<td>No</td>
<td>Don’t know</td>
<td></td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

More than half of respondents (N = 57, 53%) said they were aware of the mathematics support service at their HEI and intended to use the facility. The median MAS-UK score among these respondents was 42. The majority of these respondents were from Uni2, while the lowest number was from IoT2.

A comparatively smaller proportion of respondents (N = 14, 13.1%) did not intend using the mathematics support service at their HEI, despite being aware of the service. Among these, the median MAS-UK score was 31, considerably lower than among those who were aware of and did intend using the service. This is backed up by the median perceived ability ‘today’ ratings\(^{16}\) of these respondents which show greater confidence in their mathematics ability (median mathematics ability score = 8) than those who were aware and did intend using the service (median mathematics ability score = 6); of the fourteen respondents who did not intend using the service, 13 (92.9%) rated their ability in mathematics at the time of completion of the questionnaire as 6 or higher. While among the 57 respondents who were aware of and intended to use the service, 34 (59.6%) rated their ability as 6 or higher.

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\(^{16}\) Respondents were asked to rate their perceived ability in mathematics ‘today’, on the day of completion of the questionnaire; this was looked at in reference to the correlation with MAS-UK scores in Section 4.3.14
Over one quarter (26.1%) of respondents said they did not know if they intended to use the mathematics support at their HEI, and among these the median MAS-UK score was 44. When this result is compared with their awareness of the mathematics support, the following results are revealed (Table 4.16).

**Table 4.16 Awareness or not of the Mathematics Support service among those Respondents who did not know if they would use the Mathematics Support at their HEI**

<table>
<thead>
<tr>
<th></th>
<th>Aware = YES</th>
<th>Aware = NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>IoT 1</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>IoT 2</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Uni 1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Uni 2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
<td>14</td>
</tr>
</tbody>
</table>

Fourteen respondents were aware of the mathematics support service but did not know if they would use it; while the same amount were not aware of the mathematics support service, and did not know if they would use it. Of the fourteen that were aware the median MAS-UK score was 41, compared with 55 for those that were not aware. The range of MAS-UK scores spanned 26 to 69 for those that were aware, and 25 to 94 for those that were not aware. These results suggest less mathematics anxiety among the respondents who were aware of the mathematics support service, even though they did not know if they would use it. Further examination of the results by cross-referencing the ‘don’t know’ answers with ability in mathematics at the time of completion of the questionnaire shows that sixteen of the 28 respondents (57.1%) rated their ability in mathematics as 6 or higher.

**4.3.17 Mathematics in Respondents’ Future Careers and MAS-UK Score**

Of those respondents who answered ‘yes’ to this question, the median MAS-UK score was 41, and the range of these MAS-UK scores spanned the entire range of this cohort, from 23 to 94. This suggests that mathematics is seen by these respondents as significant to their future careers. The median MAS-UK score of the ‘no’ respondents was much higher at 63, with the 25th percentile score being at 51. Only three of the thirteen ‘no’ respondents rated their ability in mathematics today as 6 or higher. This suggests a preference not to engage with – or to avoid – mathematics. Among the ‘don’t know’ respondents, the median MAS-UK score was 43, and five of the eleven respondents (45.5%) rated their ability today as 6 or higher.
4.3.18 Mathematics Anxiety by Factor

The MAS-UK scale comprises three factors, which allow deeper investigation of the MAS-UK; the three factors are: Mathematics Evaluation Anxiety, Everyday/ Social Mathematics Anxiety, and Mathematics Observation Anxiety. The remainder of this section presents the significant correlations for each of these three factors. The non-significant correlations for each factor are presented in Appendix S.

4.3.18.1 Mathematics Evaluation Anxiety

Factor 1 is Mathematics Evaluation Anxiety and explores contexts whereby the person is actively involved in completing a mathematics task with the prospect of being evaluated by someone else (Hunt et al., 2011). Factor 1 has nine statements, as shown in Table 4.17.

<table>
<thead>
<tr>
<th>Statement No.</th>
<th>Statement</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Having someone watch you multiply 12x23 on paper</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Being asked to write an answer on the board at the front of a maths class</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Taking a maths exam</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Being asked to calculate €9.36 divided by 4 in front of several people</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Calculating a series of multiplication problems on paper</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Being given a surprise maths test in a class</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Being asked to memorise a multiplication table</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Being asked to calculate three fifths as a percentage</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Being asked a maths question by a teacher/lecturer in front of a class</td>
<td></td>
</tr>
</tbody>
</table>

The distribution of Factor 1 scores is shown in Figure 4.11. The scores range from the minimum of 9 to the maximum of 45 and the median score is 22, suggesting a positive skew. The spread of scores indicates varying levels of Mathematics Evaluation Anxiety among this cohort of mature students.
Further investigation of the Factor 1 statements elucidates those statements which presented the highest levels of anxiety; a comparison of scores for these nine statements is presented in Figure 4.12.

<table>
<thead>
<tr>
<th>Mathematics Evaluation Anxiety Statements</th>
<th>% of 5s</th>
<th>% of 4s</th>
<th>% of 3s</th>
<th>% of 2s</th>
<th>% of 1s</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Having someone watch you multiply 12x23 on paper</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Being asked to write an answer on the board at the front of a maths class</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Taking a maths exam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Being asked to calculate €9.36 divided by 4 in front of several people</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Calculating a series of multiplication problems on paper</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Being given a surprise maths test in a class</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Being asked to memorise a multiplication table</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Being asked to calculate three fifths as a percentage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. Being asked a maths question by a teacher/lecturer in front of a class</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Taking into account the percentage of 5s (very much anxious) allocated, statements 6, 18 and 23 had the highest percentages with 31%, 27% and 22% respectively. If the allocation of 4s (much anxious) is added to these giving 43%, 47%, and 43% respectively, with the order of scores changing, and statement 18 having the highest combined percentage.
Overall, these three statements present the highest levels of anxiety among this cohort, suggesting that incidents of testing and doing a mathematics problem in front of the teacher and class cause highest levels of anxiety. In contrast, the lowest scoring statements are numbers 21, 1, 10, and 7 with 53%, 51%, 47% and 39% respectively. These statements involve both calculation of a multiplication or division problem as well as being evaluated by someone, and a high percentage of these mature students present as ‘not at all anxious’ in these situations. Adding scores of 2 increases the percentages considerably higher to 69%, 75%, 71%, and 67% respectively. These low scores suggest little or no anxiety around situations of common calculations like multiplication or division either with someone present or not.

Cross referencing Factor 1 scores with other variables in the questionnaire resulted in some additional findings; these significant correlations are presented in Table 4.18.

Table 4.18 Factor 1 Significant Correlations with other Variables

<table>
<thead>
<tr>
<th>Factor 1 correlation with:</th>
<th>r</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>0.242</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Awareness of Mathematics Module before starting Programme</td>
<td>0.307</td>
<td>0.001</td>
</tr>
<tr>
<td>Ability in Mathematics at Primary Level</td>
<td>-0.380</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ability in Mathematics at Second Level</td>
<td>-0.380</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ability in Mathematics Since Leaving School</td>
<td>-0.453</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ability in Mathematics Today</td>
<td>-0.612</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Awareness of Mathematics Support</td>
<td>0.294</td>
<td>0.002</td>
</tr>
<tr>
<td>Mathematics in Respondents’ Future Careers</td>
<td>0.249</td>
<td>0.010</td>
</tr>
<tr>
<td>MAS-UK Score</td>
<td>0.942</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Three results indicate moderate to strong correlation; there is a moderate negative correlation between the respondents’ Factor 1 scores and their rating of ability since leaving school (r = -0.453, p < 0.001), suggesting lower perceived ability in mathematics since leaving school is related to higher Mathematics Evaluation Anxiety, and vice versa. There is a strong negative correlation between the respondents’ rating of ability in mathematics at the time of completion of the questionnaire and their Factor 1 scores (r = -0.612, p < 0.001), suggesting that the higher their rating of ability, the lower their Factor 1 score, and vice versa. There is a very strong positive correlation between the respondents’ scores for Factor 1 and their complete MAS-UK test scores (r = 0.942, p < 0.001), suggesting that respondents with high Factor 1 scores have high MAS-UK scores, and vice versa.
4.3.18.2 Everyday/Social Mathematics Anxiety

Factor 2 is Everyday/Social Mathematics Anxiety and explores contexts whereby the person is actively involved in performing a calculation or activity involving using numbers in an everyday situation or social context (Hunt et al., 2011). Factor 2 has eight statements, as shown in Table 4.19.

Table 4.19 Social/Everyday Mathematics Anxiety Statements in MAS-UK

<table>
<thead>
<tr>
<th>Statement No.</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Adding up a pile of change</td>
</tr>
<tr>
<td>4</td>
<td>Being asked to add up the number of people in a room</td>
</tr>
<tr>
<td>5</td>
<td>Calculating how many days until a person’s birthday</td>
</tr>
<tr>
<td>8</td>
<td>Being given a telephone number and having to remember it</td>
</tr>
<tr>
<td>11</td>
<td>Working out how much time you have left before you set off for work or place of study</td>
</tr>
<tr>
<td>13</td>
<td>Working out how much change a cashier should have given you in a shop after buying several items</td>
</tr>
<tr>
<td>14</td>
<td>Deciding how much each person should give you after you buy an object that you are all sharing the cost of</td>
</tr>
<tr>
<td>22</td>
<td>Working out how much your shopping bill comes to</td>
</tr>
</tbody>
</table>

The distribution of Factor 2 scores is shown in Figure 4.13.

![Figure 4.13 Distribution of Factor 2 Scores](image)

The scores range from the minimum of 8 to a high of 35 – no respondent scored the highest value of 40 – and the median score is 11, suggesting a positive skew. While the
spread of scores indicates varying levels of Everyday/Social Mathematics Anxiety among this cohort of mature students, most respondents have presented as low anxious in these situations. Further investigation of the Factor 2 statements elucidates those statements which presented the highest and lowest levels of anxiety; a comparison of scores for these eight statements is presented in Figure 4.14.

![Figure 4.14 Spread of Everyday/Social Mathematics Anxiety Scores by Statement with Percentage Allocation](image)

The large proportion of light blue shading (score of 1 – not at all anxious) indicates the extent of low anxiety in respect of this factor. Statements 2, 11, 13, 22, and 4 represented the least anxious situations (scores of 1) with 77% 74% 73%, 67%, and 65% respectively. Combined with the yellow shading (score of 2 – slightly anxious) these two scores represent a vast majority of the scores allocated, with 91%, 88%, 86%, 86%, and 89% respectively. These statements represent tasks people would engage with frequently and therefore are familiar to the respondents, thus resulting in low or no anxiety. The only statement that seemed to cause more notable anxiety was statement 8 – being given a telephone number and having to remember it – with 8% each for scores of 5 (very much anxious) and 4 (much anxious).

Cross referencing Factor 2 scores and other variables from the questionnaire resulted in some additional findings; the significant correlations are presented in Table 4.20. There is a very strong positive correlation between the respondents’ Factor 2 scores and their
complete MAS-UK test scores ($r = 0.849, p < 0.001$), suggesting that respondents with high Social/Everyday Mathematics Anxiety have high MAS-UK scores, and vice versa. There is a moderate negative correlation between the respondents’ rating of ability in mathematics at the time of completion of the questionnaire and their Factor 2 scores ($r = -0.481, p < 0.001$) suggesting that higher perceived ratings of ability relate to lower Factor 2 scores, and vice versa.

Table 4.20 Factor 2 Significant Correlations with other Variables

<table>
<thead>
<tr>
<th>Factor 2 correlation with:</th>
<th>r</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of Programme</td>
<td>-0.253</td>
<td>0.008</td>
</tr>
<tr>
<td>Awareness of Mathematics Module before starting Programme</td>
<td>0.244</td>
<td>0.011</td>
</tr>
<tr>
<td>Ability in Mathematics at Primary Level</td>
<td>-0.403</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Ability in Mathematics at Second Level</td>
<td>-0.289</td>
<td>0.003</td>
</tr>
<tr>
<td>Ability in Mathematics Since Leaving School</td>
<td>-0.340</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Ability in Mathematics Today</td>
<td>-0.481</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Awareness of Mathematics Support</td>
<td>0.225</td>
<td>0.020</td>
</tr>
<tr>
<td>MAS-UK Score</td>
<td>0.849</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

4.3.18.3 Mathematics Observation Anxiety

Factor 3 is Mathematics Observation Anxiety and explores contexts whereby the person takes a passive role, being in an environment with mathematical content or observing aspects of mathematics being performed by someone else (Hunt et al., 2011). Factor 3 has six statements, as shown in table 4.21.

Table 4.21 Mathematics Observation Anxiety Statements in MAS-UK

<table>
<thead>
<tr>
<th>Statement No.</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Reading the word ‘algebra’</td>
</tr>
<tr>
<td>12</td>
<td>Listening to someone talk about maths</td>
</tr>
<tr>
<td>15</td>
<td>Reading a maths textbook</td>
</tr>
<tr>
<td>16</td>
<td>Watching someone work out an algebra problem</td>
</tr>
<tr>
<td>17</td>
<td>Sitting in a maths class</td>
</tr>
<tr>
<td>20</td>
<td>Watching a teacher/lecturer write equations on the board</td>
</tr>
</tbody>
</table>

The distribution of Factor 3 scores is shown in Figure 4.15. The scores range from the minimum of 6 to the maximum of 30 and the median score is 10, suggesting a positive skew. Although the spread of scores indicates varying levels of Mathematics Observation Anxiety among this cohort of mature students, most respondents have presented as low anxious in these situations.
Further investigation of the Factor 3 statements reveals those statements which presented the highest and lowest levels of anxiety; a comparison of scores for these six statements is presented in Figure 4.16:

Figure 4.15 Distribution of Factor 3 Scores

Figure 4.16 Spread of Mathematics Observation Anxiety Scores by Statement with Percentage Allocation

Figure 4.16 shows a high proportion of 1s and 2s, indicating little or no anxiety among the respondents in most of these situations. Statements 9, 12, 16, and 17 denoted high proportions of low anxiety (scores of 1 – not at all anxious) with 63%, 56%, 51%, and 47% respectively. Combined with the scores of 2 (somewhat anxious) the figures
increased to 77%, 77%, 70%, and 72% respectively, indicating that these situations result in little or no anxiety among a majority of these mature students. The remaining two statements had slightly more varied scores: statement 15 – Reading a maths textbook, and statement 20 – Watching a teacher/lecturer write equations on the board. Combined scores of 4s and 5s resulted in totals of 18% each for both statements, indicating higher levels of anxiety in these situations.

Cross referencing Factor 3 scores and other variables from the questionnaire resulted in some additional findings; the significant correlations are presented in Table 4.2.

<table>
<thead>
<tr>
<th>Factor 3 correlation with:</th>
<th>r</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness of Mathematics Module before starting Programme</td>
<td>0.407</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Effect of Respondents updating their Mathematics Knowledge</td>
<td>0.252</td>
<td>0.009</td>
</tr>
<tr>
<td>Ability in Mathematics at Primary Level</td>
<td>-0.345</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Ability in Mathematics at Second Level</td>
<td>-0.387</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Ability in Mathematics since Leaving School</td>
<td>-0.420</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Ability in Mathematics Today</td>
<td>-0.631</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Mathematics Support</td>
<td>0.219</td>
<td>0.024</td>
</tr>
<tr>
<td>Mathematics in Respondents’ Future Careers</td>
<td>0.230</td>
<td>0.017</td>
</tr>
<tr>
<td>MAS-UK Score</td>
<td>0.859</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

There is a very strong positive correlation between the respondents’ Factor 3 scores and their complete MAS-UK test scores ($r = 0.859$, $p < 0.001$), suggesting that respondents with high Mathematics Observation Anxiety have high MAS-UK scores, and vice versa. There is a strong negative correlation between the respondents’ rating of ability in mathematics at the time of completion of the questionnaire and their Factor 3 score ($r = -0.631$, $p < 0.001$), suggesting that the higher their rating of ability, the lower their Factor 3 score, and vice versa; and a moderate negative correlation between the respondents’ ability in mathematics since leaving school and the MAS-UK score ($r = -0.420$, $p < 0.001$).

### 4.4 Conclusion

This chapter presented the analysis of the quantitative data, providing an insight into the demographics of this cohort of 107 mature students, as well as their levels of mathematics anxiety. In order to facilitate analysis of the levels and distinctive types of mathematics anxiety impacting on this cohort, the mathematics anxiety scores as presented by the MAS-UK scale were further sub-divided into the three factors of mathematics evaluation.
anxiety, everyday/social mathematics anxiety, and mathematics observation anxiety. The results presented here will be discussed in detail in chapter 7 – Findings – and chapter 8 – Discussion – in order to address the first research question. In addition, the quantitative data of the twenty mature students who opted in to participate in phase two of the research – interview – will be considered as a subset of this dataset and analysed in the next chapter.
Chapter 5 Analysis of the Quantitative Data of the 20 Interview Participants
5.0 Introduction

This chapter presents the analysis of the quantitative data of the twenty interview participants, as a separate group. Their data has already been captured and analysed as part of the larger group of 107 survey respondents. The analysis of this subset will be considered in respect of the findings that emerge, and these findings will be mixed with the findings of chapter 6, thereby adhering to step 6 of the Creswell and Plano Clark framework (section 3.3). In the interest of consistency, the layout and the content of the chapter will reflect that of chapter 4.

5.1 Background Information

This section looks at the findings for questions 1 to 5, namely:

1. Gender
2. Date of Birth
3. First language
4. What year the respondent left school
5. Name of current HEI

5.1.1 Gender of Interview Participants

There were twenty interview participants, of whom 13 were male and 7 female, with almost twice as many males (65%) than females (Table 5.1).

<table>
<thead>
<tr>
<th>Sector</th>
<th>M (N)</th>
<th>M (%)</th>
<th>F (N)</th>
<th>F (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IoT Sector</td>
<td>7</td>
<td>35.0</td>
<td>3</td>
<td>15.0</td>
</tr>
<tr>
<td>Uni Sector</td>
<td>6</td>
<td>30.0</td>
<td>4</td>
<td>20.0</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>65.0</td>
<td>7</td>
<td>35.0</td>
</tr>
</tbody>
</table>

More than twice as many IoT male students as female students responded, while this gap was narrower between Uni male and female students.

5.1.2 Date of Birth

As mentioned in section 4.1.2, mature students were the target of the survey, which required them to be aged 23 or above since January 1st 2015. Figure 5.1 shows the spread of ages of the interview participants.
The interview participants ranged in age from 24 to 49, with the median age being 34.5 years, 25% being 30 years or younger, and 75% of interview participants being under 39 years of age (75th percentile = 38.75).

5.1.3 First Language
The majority of interview participants (80%) declared English as their first language. The remaining 20% (four interview participants) stated Lithuanian, Latvian, Portuguese, and Welsh.

5.1.4 Year left School
As in section 4.1.4, the year entered by the mature student was used to calculate how many years had passed from the time they had left school to the time of completion of the questionnaire. The number of years since the interview participants had been in school ranged from 5 years to 32 years, median = 17.5 (Figure 5.2). The data are positively skewed (0.464) with negative Kurtosis (-.318). A quarter of interview participants had left school between five and 12 years (25th percentile = 12), while 75% had left school between five and twenty years. The longest periods since participants had left school were 26 years (N = 1), 30 years (N = 2) and 32 years (N = 1).
5.1.5 Interview Participants by HEI

The distribution of the interview participants according to their institution of study is shown in Table 5.2; the table includes relevant data from table 4.2.

Table 5.2 Survey Interview participants by Higher Education Institution

<table>
<thead>
<tr>
<th>HEI</th>
<th>Mature Students who Completed Questionnaires</th>
<th>Interview Participants who Completed Questionnaires</th>
<th>Interview Participants who Completed Questionnaires</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>IoT 1</td>
<td>34</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>IoT 2</td>
<td>18</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>Uni 1</td>
<td>12</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Uni 2</td>
<td>43</td>
<td>8</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>107</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

The interview participants were equally divided between the two sectors, with 50% representing both the university sector, and the institute of technology sector. Two fifths of the interview participants attend Uni 2, in contrast to 10% for Uni 1. Comparatively, the same number of interview participants represented each IoT.

5.2 Programme of Study

This section looks at the analysis of questions 6 to 9, namely:

6. What is the discipline of your programme of study at this HEI?
7. What level programme are you studying?
8. Is this programme full time/part time/other?
9. Does the programme have a mathematics module?
5.2.1 Discipline of study

The interview participants comprised students from a variety of disciplines (Table 5.3); however, the majority of interview participants were studying a programme from the discipline of Engineering, Manufacturing and Construction (40%), followed by Science, Mathematics and Computing (25%).

<table>
<thead>
<tr>
<th>Discipline of Study</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Engineering, Manufacturing, Construction</td>
<td>8</td>
<td>40</td>
</tr>
<tr>
<td>Humanities and Arts</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Science, Mathematics, Computing</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>Social Sciences, Business, Law</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Further analysis of these figures presents the breakdown of discipline by gender of interview participant (Figure 5.3). At this juncture, it is important to recall that the male participants comprise almost twice as many as female participants (65% male, 35% female).

![Figure 5.3 Interview Participants by Gender and Discipline of Study](image)

The number of male interview participants exceeds female interview participants in all categories, except for Social Sciences, Business and Law with equal numbers, and
Education with only female (N = 2) interview participants. The disciplines with the largest proportions of male participants are Engineering, Manufacturing and Construction (N = 8), and Science, Mathematics and Computing (N = 5). By contrast, Humanities and Arts participants were all male (N = 3). None of this cohort is studying a Services programme or a Health and Welfare programme.

5.2.2 Level and Mode of Programme of Study, Mathematics Module in Programme of Study

All twenty participants were full-time mature students and had mathematics modules in their programmes. Four had enrolled in a Level 7 programme of study, with the remaining 16 in Level 8 programmes.

5.3 Before you engaged with this Programme

This section looks at the findings for questions 10, 11 and 12, which asked interview participants about their awareness of the mathematics content before they applied for the programme of study, as well as asking how – if at all – they updated their mathematics knowledge before commencing the programme.

5.3.1 Before you applied for this programme, were you aware that the programme had a mathematics module?

This was a Yes/No question. A majority of 80% of participants were aware that their chosen programme of study had a mathematics module prior to applying for the programme, while 20% were unaware.

5.3.2 Before starting this programme, did you update your mathematics knowledge?

This was also a Yes/No question. Almost two thirds (65%) did not update their mathematics knowledge, while 35% did. In this case, where participants answered yes, by way of the Survey Monkey facility called ‘Page Skip Logic’ they were directed to answer question 12. In a similar way, if they answered no, the next option for those interview participants was to continue to question 13.

5.3.3 How did you update your mathematics knowledge?

This was a multiple-choice question where participants could tick all that applied. There were four defined options, and an ‘Other (please specify)’ option where answers could be typed:
• I attended a preparatory mathematics programme at this HEI
• I attended a preparatory mathematics programme at another HEI
• I obtained private tuition/grinds in mathematics
• I engaged in self-study of mathematics
• Other (please specify)

Just over one third of participants (35%, N = 7) updated their mathematics knowledge before commencing their programme of study. One response to the ‘Other, please specify’ option, referred to doing a mathematics course at the HEI, which suggested that the wording of the original question or list of options was not clear to all interview participants. Adding this response to the respective total, 30% had attended a preparatory mathematics programme at their current HEI; 25% engaged in self-study of mathematics. The remaining answers included reference to one respondent having done both higher level LC mathematics and a FETAC level 6 course, and one having done an Access Course. Four participants (20%) ticked more than one option; of these, two participants chose two options of both attendance at a preparatory mathematics programme at this HEI and engagement in self-study of mathematics. The remaining two participants chose three options, of which each had ‘attended a preparatory mathematics programme at this HEI’, and engagement in self-study of mathematics, as well as one other option each.

5.4 Other Programmes of Study Completed

This section comprised questions 13 and 14. The intention with these questions was partly to gain an insight into whether this was the participants’ first time re-engaging with education since leaving school; but also to ascertain if they had come across mathematics in that programme and how they had felt about the mathematics they encountered.

5.4.1 Have you completed any other programme of study since you left school?

This was a Yes/No question, and a majority of participants (70%, N = 14) had completed another programme of study since leaving school. If participants answered Yes, they were directed to question 14 (by way of Survey Monkey’s Page Skip Logic), otherwise they were directed to the next section of the questionnaire.

5.4.2 How did you feel about the mathematics in that programme (if applicable)?

Of those that had completed another programme, 45% (N = 9) responded to how they felt about mathematics in that programme. Where participants had indicated that mathematics
did not feature in their programme these were disregarded for question 14. Responses were analysed in terms of positive and negative responses, as well as contrasting responses or responses where there was a transition in feeling towards mathematics. Table 5.4 presents the positive, contrasting and negative comments.

**Table 5.4 How Participants felt about Mathematics in a Programme completed since they left School**

<table>
<thead>
<tr>
<th>Positive</th>
<th>Contrasting</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Repeat LC doing OL Mathematics. I found it very straightforward and comfortably gained an A1 grade</td>
<td>• It is more advanced, and as science mathematics which is about words problem gave me tough time a while before I got used to it</td>
<td>• Level 3 mathematics terrified me</td>
</tr>
<tr>
<td>• I found the mature students preparatory course very useful</td>
<td>• Reasonably happy. It's moving very fast but is manageable</td>
<td>• I'm not great at maths so a bit apprehensive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• I find it quite difficult</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• I found maths very difficult in any of my subjects</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• I have deferred my place as my Maths is not up to standard, I did get a reasonable result in school. O b3 but I do not have the extra time to put into studying chemistry and physics as well as the Maths I have forgotten over 20 years</td>
</tr>
</tbody>
</table>

This table follows the approach taken in Table 4.5, whereby the feelings expressed comprise positive and negative feelings, as well as feelings demonstrating a contrast or transition in feeling towards mathematics. The majority of comments expressed were negative feelings including how the participants perceived the mathematics: time consuming, difficult; and feelings they themselves had when doing – or anticipating doing – mathematics: not great, terrified, apprehensive, not up to standard. The positive feelings are characterised in terms of comfort with and competence in mathematics, as well as usefulness of the preparatory course. In between these extremities were two responses that illustrated a contrast or transition from one feeling about mathematics to a different way of feeling; for example, where mathematics was difficult or fast paced at first, but with time, effort, and hard work things improved.

**5.5 Rating of Ability with Mathematics at Different Time Periods**

This section asked participants to indicate how they perceived their ability in mathematics at four different periods of their lives.
5.5.1 On a scale of 1 to 10 how would you rate your ability in mathematics

This question provided participants with a table, whereby they would rate their ability in mathematics at primary school, secondary school, since leaving school, and today using a Likert scale ranging from 1 (the lowest ability) to 10 (the highest ability). Participants could only choose one rating for each time period, and this was facilitated by Survey Monkey through the use of Radio Buttons, which only allow one choice for each statement. Figure 5.4 shows the outcome.

![Graphs showing frequency of ratings for mathematics ability at different time periods](image)

Figure 5.4 Interview Participants’ Rating of Ability in Mathematics at Primary School, Secondary School, Since Leaving School, and Today

The overall rating among interview participants of perceived ability in mathematics is highest for primary level (Median = 8). This is followed by second level (Median = 6.5). Both graphs are negatively skewed, with the ratings of ability at primary level being more pronounced (Skewness = -1.312), and leptokurtic (1.463). Ratings of ability since leaving school (Median = 6) showed slight deviation from symmetry (0.019) and negative kurtosis (-.817). The rating of perceived ability today (Median = 6) presented a flatter graph with positive skew (0.113) and platykurtosis (-0.798).
5.6 Mathematics Support at this HEI

This section comprises questions 16 and 17, and asks interview participants if they are aware of mathematics support at the HEI, and of their intention to use it.

5.6.1 Are you aware of the mathematics support service at this HEI?

This was a YES/No question. Just over half of interview participants (55%) were aware of the mathematics support service at their HEI, with 45% unaware. Figure 5.5 shows the findings by HEI.

![Figure 5.5 Awareness of Mathematics Support at each HEI](image)

Of the four HEIs, 75% of Uni2 participants showed their awareness of mathematics support at that HEI, followed closely by 60% of IoT1 participants. In contrast, IoT2 is the only HEI where more interview participants are not aware (80%) than aware of the mathematics support facility at the HEI. There were only two interview participants from Uni2, with one being aware and one unaware of mathematics support.

5.6.2 Do you intend using the mathematics support service at this HEI?

This question gave interview participants three options: Yes, No, and Don’t know. The findings are depicted in Figure 5.6. Half of interview participants expressed their intention to use the mathematics support service at their HEI, while 20% were not intending to use the facility, and thirty percent did not know.
Table 5.5 presents an elaboration of the figures for intention to use mathematics support by HEI.

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>%</th>
<th>No</th>
<th>%</th>
<th>Don’t Know</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>IoT1</td>
<td>3</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>IoT2</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Uni1</td>
<td>2</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Uni2</td>
<td>4</td>
<td>20</td>
<td>3</td>
<td>15</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

A majority of Uni participants (30%) intend using mathematics support service, while 15% do not intend using the service. There is only one ‘don’t know’ response within this sector. In contrast, there is more uncertainty among the IoT participants, with more of the participants responding with ‘don’t know’ than with ‘yes’, and only one ‘no’ response.

5.7 Mathematics in your Future Career

This section wanted to ascertain if the interview participants believed that mathematics would feature in their future careers, and comprised question 18:

5.7.1 Do you envisage that your future career will involve mathematics?
The possible responses were Yes, No, and Don’t know. Almost two thirds (65%) affirmed that their future careers would involve mathematics, while 15% chose No, and 20% didn’t know.

5.8 Interview Participants’ Feelings about Mathematics at Time of Completion of the Questionnaire

This section posed one question, question 19:

5.8.1 On a scale of 1 to 10 how do you feel about mathematics right now?

This question asked after the level of anxiety the interview participants were feeling at the time of completion of the questionnaire, using a Likert scale to indicate responses, ranging from 1 (not anxious) to 10 (extremely anxious). Consonant with the intention for this question as expressed in section 4.2.10, the aim was to test for mathematics anxiety among the interviewee participants and compare the findings against the MAS-UK scores obtained. Correlation between the findings of this question and the interview participants’ MAS-UK scores showed a very strong positive relationship between the two scales (r = 0.805, P < 0.01).

5.9 Mathematics Anxiety Scale-UK Scale

The final section of the questionnaire comprised the MAS-UK scale, question 20. Interview participants were given the following instructions about this section:

For each of the 23 statements listed below, please show how you feel about each of the statements right now (rather than in the past, for example) by selecting one of the options provided. The options range from 'not at all' to 'very much'.

Please answer all 23 statements.

How anxious would you feel in the following situations right now?

The MAS-UK scale can realise a score somewhere between a minimum score of 23 and a maximum of 115 (Hunt et al., 2011). The scores of the interview participants ranged from 28 up to 94. On this occasion, the Shapiro-Wilk test showed significance of p = 0.314, which suggests the data are normally distributed; this is further confirmed with the Q-Q plot (Figure 5.7) which shows the data are reasonably normally distributed.
In addition, the values of skewness (0.339) and kurtosis (-0.369) indicate respectively that there are a greater number of low scores in the data set, and that the distribution is flat and light-tailed.

Figure 5.8 shows the distribution of the scores of the interview participants.
While there were many occurrences of scores at the lower end of the scale, no scores in this sample reflected the upper extremity of this scale, or interview participants that would be ‘very anxious’ (Hunt et al. 2011).

The chart depicts a notable gap in the range of scores between 67 and 83. The mean score of the entire sample is 55.2 [median 56.5] with a standard deviation of 18.9.

**5.10 Further Analysis of the MAS-UK Scores of Interview Participants**

In line with other studies, the MAS-UK scores were analysed to ascertain if there were links or correlations between the mature student’s MAS-UK score and other factors, such as gender, age, HEI, discipline of study, years since leaving school, and rating of ability in mathematics. These findings are presented below.

**5.10.1 Gender and MAS-UK score**

Female interview participants report slightly higher MAS-UK scores than males. The median scores for male and female interview participants are 52 and 61 respectively. The interquartile ranges are 31 (Males) and 9 (Females), as illustrated in Figure 5.9.

![Figure 5.9 Comparison of MAS-UK Scores among Male and Female Interview Participants](image-url)
The boxplot shows two outliers for the female participants, namely those with MAS-UK scores of 39 (Candidate number 20) and 86 (Candidate number 16). These two scores represent the two extremities of the females in this cohort, with the other scores being in close proximity to each other: 57, 58, 61, 64, and 66. By contrast the male MAS-UK scores show a lower median (M = 52), despite having a broader range of scores (28 to 94). Further analysis of the MAS-UK scores and Gender was done using an Independent-Samples T-Test\textsuperscript{17} to compare MAS-UK scores in male interview participants with MAS-UK scores in female interview participants. The test revealed that there was no significant difference between the male MAS-UK scores (M = 51.77, SD = 20.77) and the female MAS-UK scores (M = 61.57, SD = 13.94), \( t (18) = -1.114, p = 0.280 \).

5.10.2 Age and MAS-UK scores
There is a very weak, negative correlation between the interview participants’ Age and MAS-UK score \((r = -0.031)\).

5.10.3 Age and rating of ability in mathematics
There is a significantly strong negative correlation between the interview participants’ age and rating of their ability in mathematics at the time of completion of the questionnaire \((r = -0.67, \text{ significant at 0.01, two-tailed})\). This suggests that the older candidates in this cohort tend to have lower rates of mathematics anxiety.

5.10.4 First Language and MAS-UK Score
The median MAS-UK score is higher for interview participants whose first language is English (58) compared with interview participants whose first language is not English (44.5).

5.10.5 Years since leaving school and MAS-UK Score
There is a very weak, negative correlation between the number of years since the interview participants left school and their MAS-UK scores \((r = -0.033)\). In order to further probe if there was any relationship between the number of years since leaving school and individual statements within the MAS-UK scale, the data were tested for correlation between the number of years since leaving school and each statement on the scale.

\textsuperscript{17} The Independent Samples T-Test uses the t statistic to test whether two means collected from independent samples differ significantly (Field, 2013).
MAS-UK. This resulted in no significant findings, and only one statement showed moderate negative correlation:

*Statement 6: Taking a maths exam*

In this case, \( r = -0.441 \) suggesting the longer the number of years since the respondent has left school, the less anxious they are about taking a mathematics examination.

### 5.10.6 Years since leaving School and Rating of Ability in Mathematics

Correlation between the number of years since leaving school and how they rate their ability in mathematics today is very weak (\( r = 0.056 \)).

### 5.10.7 HEI and MAS-UK Score

Table 5.6 shows breakdown of all 20 interview participants’ MAS-UK scores and gender according to HEI; the table is sorted by descending MAS-UK score for each HEI.

<table>
<thead>
<tr>
<th>Table 5.6 MAS-UK scores for all interview participants by HEI and Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IoT1 N = 5</strong></td>
</tr>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>F</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

At a glance it is easy to identify the highest and lowest MAS-UK scores for each HEI. It is noteworthy that the three highest scores – IoT1, Male, 94; IoT2 Female, 86; Uni1, Male, 83 – are extreme scores compared with the next highest scores in each of these HEIs. The collective HEI scores by sector give a median of 57 for IoTs and 56.5 for Unis. Table 5.7 shows the median MAS-UK scores among interview participants by individual HEI.
The figures show disparity between the two groups of IoT mature students and also between the two groups of Uni mature students. At this juncture it is worth acknowledging that the frequencies for the two IoTs are the same, while those for the two Unis are disparate. Further analysis of the interview participants’ MAS-UK scores and their HEIs was done using an Independent-Samples T-Test to compare MAS-UK scores in IoT respondents (N = 10) and MAS-UK scores in Uni respondents (N = 10). The test revealed that there was no significant difference between the IoT respondents’ MAS-UK scores (Mean = 57.5, SD = 21.94) and the Uni respondents’ MAS-UK scores (Mean = 52.9, SD = 16.14), t (18) = 0.534, p = 0.600. Thus, this test shows that there is no statistically significant difference between the MAS-UK scores of the IoT participants and the Uni participants.

Table 5.8 shows a cross analysis of HEI and MAS-UK scores with Gender. For each of IoT1, IoT2 and Uni2, male interview participants demonstrate a lower median MAS-UK score compared with females. The median MAS-UK scores of IoT1 and Uni2 males and females are similar, with notably higher median MAS-UK scores for IoT2 males and females.

Table 5.8 Median MAS-UK Scores by Gender and HEI

<table>
<thead>
<tr>
<th></th>
<th>IoT1</th>
<th>IoT2</th>
<th>Uni1</th>
<th>Uni2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Median MAS-UK Score</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>43.5</td>
<td>52</td>
<td>65.5</td>
<td>44.5</td>
</tr>
<tr>
<td>Female</td>
<td>58</td>
<td>76</td>
<td>n/a</td>
<td>59</td>
</tr>
</tbody>
</table>

The median MAS-UK score for Uni1 distorts the true scores of the two students, both male, namely 48 and 83, which represent respectively low and high scores on the MAS-UK scale. In the IoT sector, male interview participants had a median score of 52, and
females a median score of 66. In the Uni sector, male interview participants also had a median score of 52, and females had a median score of 59.

5.10.8 Discipline of Study and MAS-UK score

Among this cohort, five disciplines of study are represented. Figure 5.10 presents the five disciplines in order of increasing median MAS-UK scores.

![Figure 5.10 Median MAS-UK Score by Discipline of Study](image)

Interview participants studying programmes in Engineering, Manufacturing and Construction had the lowest median MAS-UK score (45.5, N = 8); this was followed by Social Science, Business and Law (54.5, N = 2), Education (60.5, N = 2), Science, Mathematics and Computing (66, N = 5) and Humanities and Arts, which had the highest median MAS-UK score (83, N = 3). Two of the three highest MAS-UK scores are interview participants studying a programme in the Humanities and Arts discipline. The remaining high MAS-UK score belongs to the Science, Mathematics and Computing discipline; if this score (MAS-UK = 83) was omitted from the scores of this discipline, the Median MAS-UK score for the discipline would be 51.5, considerably lower than the actual median value for students of this discipline (MAS-UK = 66), and would put this discipline in second position in order of increasing Median MAS-UK scores by discipline.
5.10.9 Level of Programme of Study and MAS-UK Score

There is a considerable difference in Median MAS-UK scores among the two levels, with Level 7 students having the lowest Median score (44), while Level 8 students had a Median score of 58. An Independent Samples T-Test showed that there is no significant difference between the MAS-UK scores of Level 7 and Level 8 students ($t_{18} = -.341$, $p = .737$). However, it is noteworthy that the number of students in each level is disparate.

5.10.10 Awareness of Mathematics Module before starting Programme

Comparing the MAS-UK scores of those interview participants who were aware ($N = 16$) there was a mathematics module in their programme of study before applying for the programme, with those who were not aware ($N = 4$) shows a slight difference in median MAS-UK scores; those who were aware have a median MAS-UK score of 46, while those who were not aware had a median MAS-UK score of 58. The range of MAS-UK scores among those who were aware of mathematics in their programme was from 28 to 94, thus including the lowest and highest MAS-UK scores of this cohort; in contrast, the range among those who were not aware was much more compact, namely from 48 to 66. Further investigation into the ‘not aware’ interview participants found that all four have English as a first language, so lack of knowledge about the programme having a mathematics module is not due to potential language difficulties.

5.10.11 Effect of Interview participants updating their Mathematics Knowledge

Almost two-thirds (65%, $N = 13$) of interview participants did not update their mathematics knowledge before starting at the HEI, while seven did. A comparison of the median MAS-UK scores of those participants who did update their mathematics knowledge before they started the programme with those who didn’t shows considerable differences in the median MAS-UK scores, with median = 39 and median = 59 respectively. Figure 5.11 shows the spread of the MAS-UK scores for those who did (Yes) and those who did not (No) update their mathematics knowledge.
There is a higher median MAS-UK score for the No interview participants (59). The Boxplot also depicts four outliers – two high MAS-UK scores (86 and 94) and two low MAS-UK scores (31 and 37). While the skew of data is positive for both groups of interview participants – 0.279 for Yes interview participants, and 0.123 for No interview participants – the MAS-UK scores of Yes interview participants are more positively skewed than those of No interview participants, suggesting that the additional preparation in mathematics before commencing the programme of study likely resulted in the Yes interview participants being less mathematics anxious than the No interview participants.

5.10.12 Other Programmes of Study completed and MAS-UK Score

A majority of interview participants (70%) had completed another programme of study since leaving school. Their median MAS-UK score was higher: median = 60 compared with median = 43.5 for those who had not completed a programme of study. Further analysis of this data cross-referenced with the data on whether they had updated their mathematics knowledge before starting at their current HEI is depicted in Table 5.9.
Table 5.9 Cross Reference of whether Students who completed another Programme of Study also updated their Knowledge of Mathematics and corresponding Frequencies and Median MAS-UK Scores

<table>
<thead>
<tr>
<th>Other Programme Completed</th>
<th>Updated Mathematics Knowledge</th>
<th>Yes (Median MAS-UK score)</th>
<th>No (Median MAS-UK score)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
<td>4 (44.5)</td>
<td>10 (65)</td>
</tr>
<tr>
<td>No</td>
<td></td>
<td>3 (39)</td>
<td>3 (48)</td>
</tr>
</tbody>
</table>

A majority of participants (50%, N = 10) had completed another programme of study but had not updated their mathematics knowledge before starting at their current HEI; in addition, the median MAS-UK score for this cohort was 65, suggesting a comparatively considerable amount of anxiety towards mathematics. This suggests that not updating their mathematics knowledge may have contributed to the level of anxiety. By contrast, the other subgroups have lower median MAS-UK scores, with the lowest (median = 39) referring to the students not having completed another programme of study but having updated their mathematics knowledge before starting at the HEI. It is possible that not having done another programme meant that the students took a fresh approach to starting higher education and took it upon themselves to be prepared for mathematics. Again, it is noteworthy to observe that the sample is small.

5.10.13 Feelings about Mathematics in another Programme of Study and MAS-UK Scores

Table 5.10 presents the positive, contrasting, and negative comments and includes the MAS-UK score for the student who wrote each comment. MAS-UK scores for the positive comments are low, ranging from 28 to 37, while those for the negative comments are notably higher, ranging from 58 to 94.
Table 5.10 Feelings about Mathematics in another Programme of Study and MAS-UK Scores of Respondents

<table>
<thead>
<tr>
<th>Positive</th>
<th>Contrast/Transition</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Repeat LC doing OL Mathematics. I found it very straightforward and comfortably gained an A1 grade. (37)</td>
<td>• It is more advanced, and as science mathematics which is about words problem gave me tough time a while before I got used to it. (33)</td>
<td>• Level 3 mathematics terrified me (59)</td>
</tr>
<tr>
<td>• I found the mature students preparatory course very useful (28)</td>
<td>• Reasonably happy. It's moving very fast but is manageable. (56)</td>
<td>• I'm not great at maths so a bit apprehensive (66)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• I find it quite difficult (58)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• I found maths very difficult in any of my subjects. (94)</td>
</tr>
</tbody>
</table>
|                                                                         |                                                                                      | • I deferred my place as my Maths is not up to standard, I got a reasonable result in school. O B3 but I do not have the extra time to put into studying chemistry and physics as well as the Maths I have forgotten over 20 years (86)

Those representing the contrast or transition lie in between the previously mentioned ranges, with a range of 33 to 56. There are also more negative comments about the respondents’ experiences with mathematics.

5.10.14 Rating of Ability in Mathematics and MAS-UK Score

There is a significantly strong negative correlation among the interview participants’ rating of their ability in mathematics at the time of completion of the questionnaire and their MAS-UK scores (r = -0.680, significant at 0.01 level two tailed), suggesting that the higher their perceived ability in mathematics, the lower their MAS-UK scores, and vice versa.

5.10.15 Awareness of Mathematics Support and MAS-UK Score

There is little difference between the median MAS-UK scores of interview participants who knew about mathematics support at the HEI and those who did not: median = 56 compared with median = 57. This suggests interview participants who are aware of mathematics support are slightly less mathematics anxious than those who are not aware. Table 5.11 shows the breakdown of these figures according to HEI sector.

Table 5.11 Awareness of Mathematics Support, Median MAS-UK Scores and Number of Respondents

<table>
<thead>
<tr>
<th>IoT</th>
<th>Aware</th>
<th>Not Aware</th>
<th>Uni</th>
<th>Aware</th>
<th>Not Aware</th>
</tr>
</thead>
<tbody>
<tr>
<td>IoT</td>
<td></td>
<td></td>
<td>Uni</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median MAS-UK Score</td>
<td>57</td>
<td>59</td>
<td>56</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>4</td>
<td>6</td>
<td>7</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>
While the numbers in each category here are small and varied, the category with the highest median MAS-UK score was IoT interview participants who were not aware of mathematics support (median = 59). The other three median scores are closer, with that of IoT interview participants who did know being 57, and of Uni interview participants being 56. Uni interview participants who did not know have a median score of 57.

The figures for the individual HEIs are shown in Table 5.12. The median MAS-UK scores for Uni1 are indicative of individual student scores, as there were only two students interviewed from this HEI, with one being aware of mathematics support – MAS-UK score of 83 – and the other not being aware – MAS-UK score of 48. One IoT2 respondent who was aware of mathematics support scored a relatively high rate of mathematics anxiety; however, the four remaining IoT2 interview participants with a median MAS-UK score of 59 were not aware of mathematics support.

Table 5.12 Median MAS-UK Scores and Number of Interview Participants by individual HEI

<table>
<thead>
<tr>
<th></th>
<th>Aware</th>
<th></th>
<th>Not Aware</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median MAS-UK Score</td>
<td>N</td>
<td>Median MAS-UK Score</td>
<td>N</td>
</tr>
<tr>
<td>IoT1</td>
<td>56</td>
<td>3</td>
<td>62.5</td>
<td>2</td>
</tr>
<tr>
<td>IoT2</td>
<td>67</td>
<td>1</td>
<td>59</td>
<td>4</td>
</tr>
<tr>
<td>Uni1</td>
<td>83</td>
<td>1</td>
<td>48</td>
<td>1</td>
</tr>
<tr>
<td>Uni2</td>
<td>47.5</td>
<td>6</td>
<td>60.5</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>11</strong></td>
<td></td>
<td><strong>Total</strong></td>
<td><strong>9</strong></td>
</tr>
</tbody>
</table>

This suggests that IoT2 interview participants are not as well informed about the mathematics support service at that institution compared to interview participants from other HEIs. For the remaining HEIs – IoT1 and Uni2 – the median MAS-UK scores are considerably lower for those interview participants that did know about mathematics support (56 and 47.5 respectively), than those in the same HEIs who did not know (62.5 and 60.5 respectively).

5.10.16 Intention to use Mathematics Support and MAS-UK Score

More than half of interview participants (N = 11, 55%) said they were aware of the mathematics support service at their HEI. Half of interview participants (N = 10, 50%) said they intended to use the facility. The median MAS-UK scores among these interview participants was 56 and 50 respectively. Table 5.13 shows the cross reference of responses to the interview participants’ awareness of the facility and their intention to use it. A
majority of interview participants (N = 8, 40%) were both aware of the mathematics support service at their HEI and intended to use it. Their corresponding median MAS-UK score was 47.5. In contrast, those who were not aware but did not intend using the service had a slightly lower MAS-UK score (47), although the number of participants was small (N = 2, 10%). Higher median MAS-UK scores were present among those who did not know if they intended using the mathematics support service, despite being aware (67) or not aware (66); again, small sample size needs to be acknowledged.

Table 5.13 Awareness of and Intention to use Mathematics Support Service with Median MAS-UK Score

<table>
<thead>
<tr>
<th></th>
<th>Intend</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td>Don’t Know (DK)</td>
<td></td>
</tr>
<tr>
<td>Aware</td>
<td>Median MAS-UK</td>
<td>N</td>
<td>Median MAS-UK</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>47.5</td>
<td>8</td>
<td>57.5</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>2</td>
<td>47</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>67</td>
<td>1</td>
<td>66</td>
<td>5</td>
</tr>
</tbody>
</table>

Further cross-referencing with the interview participants’ ratings of ability ‘today’, i.e. at the time of completion of the questionnaire, showed that those who were aware of and intended to use the service had a high median ability rating of 8.5/10; those who were not aware and did not intend using the service had a median ability rating of 7/10; and those who were not aware but did not know if they intended using the service had a comparatively low median ability rating of 3/10.

5.10.17 Mathematics in Interview Participants’ Future Careers

Of those interview participants who answered ‘yes’ to this question (N = 13), the median MAS-UK score was 52, and the range of MAS-UK scores spanned from 28 to 94. This suggests that mathematics is seen by these interview participants as significant to their future careers. The median MAS-UK score of the ‘no’ interview participants was considerably higher at 64. In addition, only seven of the thirteen ‘yes’ responses rated an ability in mathematics today as 6 or higher.

5.11 Mathematics Anxiety by Factor

This section looks at each of the three MAS-UK factors in turn: Mathematics Evaluation Anxiety, Social/Everyday Mathematics Anxiety, and Mathematics Observation Anxiety, and presents the significant correlations between each factor and variables from the questionnaire.
5.11.1 Mathematics Evaluation Anxiety

As was outlined in section 4.3.18.1, Factor 1 has nine statements pertaining to situations involving mathematics evaluation and testing. The scores of the twenty students range from 12 to 42 (from a possible range of 9 to 45), with the median score at 25, and indicating varying levels of mathematics anxiety. Figure 5.12 presents the breakdown of scores by statement. The statements with the highest number of 5s include statements 6, 18 and 23, each of which involves taking a mathematics test or being asked a question in front of the class. If the percentage of scores of 4 is added to the scores of 5 for these statements, it shows that 70% of students rated statement 6 as much or very anxious. Similarly, statement 23 yields 60% of responses as 4s and 5s, while statement 18 yields 50%. In addition, statements 6 and 18 yielded no scores of 1, indicating all of these students showed at least some anxiety towards these scenarios. Further, if percentages for scores of 3, 4 and 5 are combined, statement 6 yields a very high 95%, followed by statement 18 with 75%, statement 23 with 70%, and statement 3 with 65%. This indicates there is considerable anxiety among a majority of these students in respect of such situations of evaluation.

Figure 5.12 Spread of Mathematics Evaluation Anxiety Scores by Statement with Percentage Allocation.
In contrast, the lowest scoring statements with scores of 1 are statements 21, 1 and 10, with percentages of 50%, 30% and 30% respectively. Combining scores of 1 and 2 shows little or no anxiety among these students in respect of statements 21, 1, and 10 yield percentages of 65%, 60% and 60% respectively. In addition, statement 10 had no scores of 5, indicating no student was very anxious in this scenario. These low scores suggest little or no anxiety in situations involving calculating multiplication or division problems.

Table 5.14 presents the significant correlations between Factor 1 – Mathematics Evaluation Anxiety – and variables from the questionnaire.

<table>
<thead>
<tr>
<th>Factor 1 Score correlated with:</th>
<th>r Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability since leaving School</td>
<td>-0.516, p = 0.020</td>
</tr>
<tr>
<td>Ability Today</td>
<td>-0.660, p = 0.002</td>
</tr>
<tr>
<td>Feel anxious about Mathematics now</td>
<td>0.756, p &lt; 0.001</td>
</tr>
<tr>
<td>MAS-UK Score</td>
<td>0.930, p &lt; 0.001</td>
</tr>
</tbody>
</table>

There is a moderate negative correlation between the Factor 1 scores and the participants’ rating of ability in mathematics since leaving school (r = -0.516, p = 0.020), suggesting lower perceived ability in mathematics since leaving school is related to higher Factor 1 scores, and vice versa. There is a strong negative correlation between the participants’ rating of ability in mathematics at the time of completion of the questionnaire and their Factor 1 scores (r = -0.660, p = 0.002), suggesting that the higher their rating of ability, the lower their Factor 1 score, and vice versa. There is a strong positive correlation between the Factor 1 scores and how anxious the participants felt about mathematics at the time of completion of the questionnaire (r = 0.756, p < 0.001). There is a very strong positive correlation between the Factor 1 scores and the complete MAS-UK test scores (r = 0.930, p < 0.001), suggesting that respondents with high Factor 1 scores have high MAS-UK scores, and vice versa.

5.11.2 Everyday/Social Mathematics Anxiety

As was outlined in section 4.3.18.2, Factor 2 has eight statements pertaining to situations involving mathematics in everyday or social situations. The scores of the twenty students range from 8 to 27 (from a possible range of 8 to 40), with the median score at 13, and indicating low levels of mathematics anxiety in such situations. Figure 5.13 presents the breakdown of scores by statement. It is evident that there is a large proportion of ls among the data set, suggesting no anxiety among these students in such situations. Similarly,
when scores of 1 and 2 are added there are percentages of 80% or higher for all statements except 8. It is likely that this is a task people would not have to engage with frequently, and may as a result cause increased levels of anxiety.

Figure 5.13 Spread of Everyday/Social Mathematics Anxiety Scores by Statement with Percentage Allocation.

Statements 8 and 11 were the only statements to yield scores of 5, albeit with small percentages of 15% and 5% respectively. Only one variable, MAS-UK score, has a significant correlation with Factor 2 – Everyday/ Social Mathematics Anxiety ($r = 0.684$, $p = 0.001$). This shows a strong correlation between Factor 2 and the MAS-UK score, suggesting that participants with low Factor 2 scores have low MAS-UK scores, and vice versa.

5.11.3 Mathematics Observation Anxiety

As was outlined in section 4.3.18.3, Factor 3 has six statements pertaining to situations involving observing mathematics being performed by someone else. The scores of the twenty students range from 6 to 28 (from a possible range of 6 to 30), with the median score at 13, and indicating varying levels of mathematics anxiety. Figure 5.14 presents the breakdown of scores by statement.
Figure 5.14 Spread of Mathematics Observation Anxiety Scores by Statement with Percentage Allocation.

Figure 5.14 shows high proportions of low levels of anxiety, with percentages of 40% or above for combined scores of 1s and 2s, showing little or no anxiety in these situations. Statement 12 has no scores of 5. However, there are relatively larger proportions of scores of 3 in statements 15, 16 and 20; these combined with the scores of 4 and 5 show that 60%, 50% and 55% of these students respectively are somewhat, much or very anxious in these situations. In each of these three statements there is a sense that the student does not understand what they are observing, whether in a textbook, or writing out a problem whether on the board or otherwise.

Table 5.15 presents the significant correlations between Factor 3 – Mathematics Observation Anxiety – and variables from the questionnaire.

Table 5.15 Factor 3 Significant Correlations with other Variables

<table>
<thead>
<tr>
<th>Factor 3 Score correlated with:</th>
<th>r Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability Secondary School</td>
<td>-0.508, p = 0.022</td>
</tr>
<tr>
<td>Ability Today</td>
<td>-0.544, p = 0.013</td>
</tr>
<tr>
<td>Feel anxious about Mathematics now</td>
<td>0.760, p &lt; 0.001</td>
</tr>
<tr>
<td>MAS-UK Score</td>
<td>0.851, p &lt; 0.001</td>
</tr>
</tbody>
</table>
There are moderate negative correlations with Factor 3 in respect of ability in mathematics at secondary school ($r = -0.508$, $p = 0.022$), and at the time of completion of the questionnaire ($r = -0.544$, $p = 0.013$) suggesting that the higher their rating of ability in each case, the lower their Mathematics Observation Anxiety, and vice versa. There is a strong positive correlation between the respondents’ Factor 3 scores and their feeling of anxiety towards mathematics at the time of completion of the questionnaire ($r = 0.760$, $p < 0.001$). There is a very strong positive correlation between the respondents’ Factor 3 scores and their complete MAS-UK test scores ($r = 0.859$, $p < 0.001$), suggesting that respondents with high Mathematics Observation Anxiety have high MAS-UK scores, and vice versa.

5.12 Conclusion

This chapter has presented the analysis of the quantitative data for the twenty interviewees. The format has followed that of chapter 4 in order to present relevant findings with respect to the demographics for these twenty mature students, and their levels of mathematics anxiety. These findings provide an insight into the levels of mathematics anxiety as well as the factors of mathematics evaluation anxiety, everyday/social mathematics anxiety, and mathematics observation anxiety. In this regard, they provide a context with which to approach the combining of data sets – quantitative and qualitative – to facilitate the interpretation of the findings and address research question 2.
Chapter 6 Analysis of the Qualitative Data
6.0 Introduction

This chapter presents the analysis of the qualitative data. Having completed the questionnaire in Phase One, all respondents were invited to ‘opt in’ by providing contact details – email address and/or mobile phone number for text messaging – to enable them to be contacted to participate in a one-to-one interview. A total of sixty-four mature students submitted contact details; these students were emailed, twenty-one responded and were willing to meet for an interview. In all, twenty mature students participated in the interview process, with the twenty-first candidate not being able to participate due to family circumstances. The chapter presents each question or topic for discussion posed during the interview, and the analysis of the responses. The list of indicative questions posed to the participants is presented in Figure 6.1.

| 1. When you think of mathematics, how does it make you feel? |
| 2. Tell me about your earliest memories of doing mathematics/mathematics at primary level |
| 3. Tell me about your experiences of doing mathematics at secondary school |
| 4. Tell me about your experiences of engaging with mathematics after school |
| 5. Tell me about the role of mathematics in your decision to return to HE |
| 6. Tell me about the mathematics in your current programme |
| 7. Have there been any significant people in terms of your engagement with mathematics? |
| 8. What has been/How would you describe your strategy with mathematics? |
| 9. Do you think mathematics will be part of your future? |
| 10. What theme would you use to characterise your relationship with mathematics? |

Figure 6.1 Indicative Questions posed during Interview

Each question in itself provided an a priori theme with which to analyse the data. However, within each a priori theme a number of additional, related sub-themes emerged. These are presented in each section and are accompanied with a percentage value in summary format at the start of each section; this percentage value indicates the percentage the sub-theme was mentioned across all twenty transcripts.

6.1 Question 1: When you think of mathematics, how does it make you feel?

This was the opening question to the interview, and the intention was to get participants to think about their feelings towards mathematics from the outset of the interview. For some participants this question elicited a simple one-sentence response; for others it evoked a descriptive piece about their engagement with mathematics, in some instances going back to primary school. Figure 6.2 lists the themes for this question.
List of Themes (Percentage mentioned):
- Positive Responses (3%)
- Negative Responses (12.9%)
- Context for doing Mathematics (4.3%)
- Contrast between doing practical Mathematics and academic Mathematics (3.7%)
- Contrast showing Changes in Feelings towards Mathematics (10.5%)

Positive Responses

Con appreciates the appeal of mathematics and sees the benefit of mathematics in the applied subjects like physics and engineering:

*I have a great interest because of the all-encompassing nature of it, without really feeling I have a solid grasp of the basic workings of it, and that adds to the interest in it, where it goes from the very simple to the all-encompassing laws of the universe, and how everything can be explained by mathematics.*

Mike ‘loved mathematics’ when he was in secondary school. Lisa also feels positive about mathematics, even though it is not one of her favourite subjects:

*I wouldn’t say that it’s one of my very favourite subjects but I’m more neutral about it. I don’t have any difficulties with it, so I’m not anxious when I’m thinking about maths. It’s more positive feelings than negative.*

Negative Responses

Kate feels she was never good at mathematics, and she knew this all through her schooling she admits it was a different culture that lacked guidance:

*I knew I wasn’t good at maths, even in primary. I remember getting resource for a while, and I always found it tricky. When I went to secondary, I remember they brought in foundation level maths. And [it was] recommended that I do that. And I probably shouldn't have, instead of maybe putting the work in. But it was a different culture then, there was no real guidance, or saying, this will be the better option for you.*

For Gayle mathematics is an ongoing worry and she prefers to avoid mathematics if possible:
When I see figures on a page, I worry, and I suppose, I’ll even skip over them, if it’s a statistical thing, I just find that I completely brush over that. I can read the text, but I don’t engage with the figures.

James feels anxious about mathematics and fearful in respect of mathematics examinations, but acknowledges the importance of mathematics in order to get into higher education programmes:

For the Leaving Cert, I would have wanted to get as many points as possible. So, the weakest subject I was doing was maths. I think the fear is just in relation to the possibility of not passing maths, and I can remember at that time maths for some courses at third level was a requirement.

Lynn is fearful about mathematics and has to deal with it often as she helps students in a post-primary school. If she does not see the relevance of mathematics, it makes it difficult to grasp the concept:

Fearful. I'm dealing with it at the moment because I’m volunteering in a school two days a week, so I have to do foundation maths with a Leaving Cert student and I find it very difficult. I don’t know the formulas, I never came across them. For example, last Friday I had to do you know speed, distance and time and I didn’t know dad’s silly triangle, that formula, I didn’t know it.

Pat feels a sense of panic if he has to engage with numbers, particularly algebra. He believes he could have liked numbers if he had been taught the right way:

I don’t like them, and they don’t like me. ... even today it’s after affecting me so badly that I see numbers and I panic. I get really, really, really panicky ... it’s awful for me to sit in a maths class and thinking about it I get panicky, but it goes all the way back through my childhood all the ways up, and I could have been a kid that liked numbers, if I got taught the right way.

Shay feels he is not confident with mathematics and has not performed well in mathematics over time:

I’m not very confident with it. Mainly due to the fact that I didn’t like my skills and knowledge within maths, it’s not amazing, it could be a lot better. And I think my performance [has] shown that.

Tina feels a sense of dread when it comes to mathematics, and feels she was not good at mathematics growing up:

Dread I suppose, I’ve just never been a fan really of maths you know, ... plus it gets harder I think as you get older, more complicated. And I find
maths just one of them things, you know when you have them little riddles and it’s like you have to picture everything. So, I confuse myself more than anything.

Eve feels dread towards mathematics and acknowledges the long time she has been out of school as being a factor:

Well in college I just dread it, because it’s been so long since I did my Leaving Cert in 99 and I did science in [other HEI] for a year and a half … but I found it much easier to do maths [there] in comparison to here. … So I just dread it.

Context for doing Mathematics

Dan was comfortable with mathematics until he had to do LC honours mathematics as a mature student in order to apply for his HE programme:

I had a fairly good run up until last year, until I started this course. Because it was a bit of a shock to the system and I’d never done honours maths before and you needed it for the course I’m doing. So, I did the Leaving Cert again.

Neo’s outlook on mathematics has evolved over his life, from feeling indifferent about mathematics at primary school to feeling frustrated and anxious in secondary school:

At an early stage, maths was just another thin thing you did in school in between playtime. … But, in first year I started feeling that maths was a subject that was beginning to slip through my fingers, and that was a horrible feeling. Because you’d go home and look at books and you have questions, and … it was really frustrating not being able to ask the question to get the answer so that I could rationalise it.

Contrast between doing practical Mathematics and academic Mathematics.

Jon can engage with numbers and everyday mathematics comfortably, but has difficulties with academic mathematics, particularly algebra:

Every day maths I have no problem with, I can do percentages, ratios, all the regular stuff in my head no problem. I had to use it in my job for fourteen years. When it comes to putting the alphabet into it, I have serious issues.

Mark likes the practical application of mathematics and likes to see the relevance of it and be able to visualise it, but does not like more abstract mathematics that have no context:

I enjoy physics, and working with the maths, but I don’t like actual maths lectures, unless there’s a problem where I can apply in real life.
... I love doing that, but if you say like $3x^2 + 2x^2$ [it's] just numbers and letters. ... And most of the time my approach to problems is trying to visualise the end result, or the actual components of the problem.

Contrast showing Changes in Feelings towards Mathematics

Alec felt ‘comfortable’ with his primary and post-primary mathematics education, but it got more challenging in the Senior Cycle, with a high volume of work. In HE he is getting by, despite failing in-class tests:

[I did] higher level maths for Junior Cert. I stuck it out until the first year of Leaving Cert course, but I found the going very heavy, ... a more difficult level. Two years ago went back to college and I did struggle with maths and the in-class tests I was failing but somehow by the end I was scraping a pass.

Anna really likes mathematics, but when she gets stuck with a mathematics problem she may not know how to continue and that makes her feel disappointed:

Mathematics is something I really like. But when I have to do exercises, I get very anxious. I don’t feel very comfortable. Because when I get to a point where I don’t know how to carry on I feel disappointed, and I don’t like feeling like this because I’d like to perform better.

Evan recalls feeling anxiety towards mathematics after he changed schools. The small class sizes afforded individual attention and that helped his competence in mathematics, and lessened his anxiety towards the subject:

By [age] 6 ... I could add and subtract as along as it didn’t involve carrying. The family then moved [house] ... I was given a lot of 1 to 1 attention from [teacher] and ... was [soon] up to the standard of my peers. The difference was [small] class sizes. As I became better at maths, I no longer had maths anxiety except for ... mental arithmetic, at which I’m still quite poor.

Ken feels comfortable with some aspects of mathematics and confused with others. Seeing the relevance of mathematics is important to him. Examination questions can be vague, and he can get confused in this situation:

In some ways I’m comfortable with it, but then in other ways ... it takes [time to] grasp of what’s going on. But once I get the hang of it, I can muddle my way through it. I find a lot of the questions that are asked in an examination [are] vague, in that, when I look at the question, I’m thinking what is it I’m supposed to do. You know that’s the part I get confused over.
Sam commented that his mathematics had improved in the past year, whereas prior to this he would have felt anxious and nervous about doing mathematics:

*Before this year I would have said very anxious and quite nervous about being found with a lack of ability to do it but after seeing I can handle it, I'm not that apprehensive about it anymore. I still wouldn't say I’m 100% confident but I’m far more comfortable with it than I was.*

**Summary**

**Question 1: When you think about mathematics, how does it make you feel?**

The highest percentage of responses (12.9%) to this question were negative, and included:

- Negative adjectives describing the feelings, such as uncomfortable, not confident, frustrated, confused, nervous, anxious, worry, dread, fear, as well as the extremes of panic, switching off;
- The process of doing mathematics; not enjoying it, not understanding it, vague, a mystery, tricky, difficult, hard, not knowing what to do, learning mathematics off, mathematics not making sense, not applying to real life situations, putting the alphabet into mathematics;
- The mindset: never been good with mathematics, getting harder as you get older, not being able to visualise the mathematics;
- The learning environment: sitting in a mathematics class being awful, so long since last doing mathematics, pace of mathematics class.

Positive responses were fewer (3%) and included feeling comfortable, or confident with mathematics; mathematics as a favourite subject, and loving mathematics. The contexts for doing mathematics (4.9%) in respect of the feelings expressed pertained to the education system, namely at primary level, second level, and HE.

Some participants expressed a contrast between doing practical or everyday mathematics and academic mathematics (3.6%). The dichotomy of liking mathematics but feeling uncomfortable in challenging situations was also expressed. Additional contrasts among responses showed changes in the students’ feelings towards mathematics between levels of education (10.5%); primary-secondary, secondary-higher education (HE), enrolling as a mature student having been out of the academic environment for some years.

**6.2 Question 2: Tell me about your earliest memories of doing mathematics/mathematics at primary level**

This question sought to bring the student back to the start of their encounter with mathematics, and their earliest memories of mathematics, typically in the primary school context. For some students this was a happy time with good memories of learning
mathematics, however, for others, it represented an unhappy time and – in some cases – the start of their dislike of mathematics. Figure 6.3 lists the themes for this question.

<table>
<thead>
<tr>
<th>List of Themes (percentage mentioned):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The Public Context (14.7%)</td>
</tr>
<tr>
<td>• Times Tables (8.2%)</td>
</tr>
<tr>
<td>• Other Mathematics Topics (3.9%)</td>
</tr>
<tr>
<td>• Enjoyment of Mathematics at Primary School (5.4%)</td>
</tr>
<tr>
<td>• Support for the Learner (7.5%)</td>
</tr>
</tbody>
</table>

Figure 6.3 Themes for Question 2 and Percentages mentioned

The Public Context (doing a mathematics problem or answering a mathematics question in front of others, often standing up)

For some participants their anxiety towards mathematics stemmed from having to engage with mathematics in front of their classmates at primary school. This involved usually standing up at the top of the class, and being asked a question; one such experience was recounted by Gayle:

_We’d all stand at the top of the class, so when you got your multiplication table wrong, you’d have to sit down. ... I think that’s what happened. ... you have to stand at the top of the class and reel them off, and that was definitely an anxiety for me. But that was the way they did it._

For Gayle, sitting down again meant you had got the answer wrong. Similarly, for Tina, there was anxiety about standing up in front of her peers and that remains with her today:

_That was bad enough, having to stand, ... Sure, that alone when you’re a child, you’d be anxious of that. I’d still be anxious now if someone asked me to stand up and do something._

Pat has always had difficulty with mathematics and this stems from early in his primary education:

_It’s been stressful since I started primary school. ... If I got individually asked I’d blank._

Ken acknowledges the importance of times tables as being a precursor to all mathematics that followed, and recalls being punished for not knowing them:

_Everything with maths was based on you knowing your times tables, ... and I used to get punished in school if I didn’t know them, because when you are a kid you’re like a goldfish aren’t you, once around the bowl_
and you forget everything. And I’d often forget it, so you would be punished for that.

Jon presented his memory of doing mathematics at primary school as ‘a regime of terror,’ having suffered verbal and physical abuse at the hands of the teachers:

If you got the slightest thing wrong, you got beat, and one teacher would slap you across the knuckles. Another teacher would beat you, just lose her temper because she felt you were thick, and that’s what she would be telling you. The headmaster wasn’t that bad, but we were all terrified of him. Still I could do maths up to that, you know they were every day maths. ... I remember in classes particularly in primary school, everybody would be putting up their hands to say something and they wanted to answer it and I put up my hand as well, and hoped that I wasn’t asked. And I remember a couple of times I was asked, I forgot, and you know they let me off with that.

For Jon, the physical punishment he received for getting mathematics wrong did not seem to prevent him from being able to do his mathematics, but the impact of the ‘regime of terror’ accompanied his journey through primary school and beyond.

**Times Tables**

Having referred to times tables in the above section, some other examples of the impact of times tables follow. For some participants, there was an emphasis on learning tables by memorising them. Alec recalls being ‘comfortable’ memorising tables, and Sam was ‘fine’ with doing times tables. Both Ken and Eve recall tables ‘being drummed into’ them; but Eve reflects on the benefits of this nowadays, and she is able to recall up to 12 times tables relatively fast, and she contrasts that approach with how her children learn mathematics nowadays, whereby they do not have to learn off tables, and of which she disapproves.

Pat feels he has never been good with mathematics and recalls doing times tables and the sense of panic it brings:

*I’ve never been good at maths, never, never, ... back to times tables I remember back because, anytime I see numbers, I start panicking. ... Even today I find that if I have to count something, I’d count it on my fingers instead of using a calculator. It’s just a comfortable way for me to do maths.*

Pat identified there was a ‘rhythm’ to saying off the tables, and he mimicked that approach, in order that the teacher would think he was saying his tables. But the reality was that he didn’t know them.
In school we’d all go through the times table, ‘one and one’ and so forth and you get a rhythm going. I used be the fella that would go with the rhythm but not say them, because I wouldn’t know the answers.

Gayle’s experience of times tables was not a positive one, and there was a sense of intimidation by others in her class, which has had a lasting effect:

If you ask me to stand up and do multiplication tables, or division, that would send a shiver down my back. … I can remember one particular student who was excellent at maths, and I’d have to stand beside him, and he just sticks in my mind, because he was so good at reaming off multiplication tables.

After moving to a new school, Evan recalls his surprise at the other kids doing their tables using a ‘numbers song’:

To my astonishment the whole school sang a "numbers song" in the morning, the times tables. At this point I felt woefully inadequate in terms of my academic development, and that would be a peak in my maths anxiety.

However, the school had small numbers in attendance and he got one-to-one attention from his teachers when he needed it; this helped his mathematics development in primary school.

Other Mathematics Topics

For many participants their earliest memories of doing mathematics involved counting, adding and subtracting, and basic arithmetic. Evan recalls being able to add and subtract until it came to ‘carrying’ which he struggled with. James started to have difficulty with mathematics when ‘there were more numbers being brought in’ and he was ‘introduced to multiplication, division, and fractions.’ Dan also found long division ‘a struggle to remember how to do it.’ Lisa had difficulty with geometry, as it was on ‘a different level.’

Enjoyment of Mathematics at Primary School

Doing mathematics at primary school was a positive experience for some, with comments including ‘comfortable with maths’ [Alec], ‘enthusiastic about maths’ [Dan], ‘enjoying maths’ [Ken]. Mark commented that his ‘parents … were saying I was really good at maths, and I remember myself I was good.’ Similarly, Sam enjoyed mathematics, saying it ‘was very handy, enjoyed it, found it easy, flew through it.’ Shay recalls his strengths in mathematics as ‘adding, subtracting numbers and multiplying.’
In contrast, Pat did not enjoy mathematics at primary school, and he talked about a lack of understanding of mathematics and the impact it has on him currently:

*The information wasn’t going in, it wasn’t registering with me, and I do suffer now for that … when I look back I am suffering now because I didn’t learn then. It’s not I didn’t learn, I couldn’t learn, it wasn’t registering.*

He managed to get through primary school, but his tendency was to put off doing his mathematics:

*I remember getting homework and I’d do English, Irish, I’d do everything, and I’d leave the maths to last because I knew it was tough.*

**Support for the Learner**

Support for the learner came through individual attention from the teacher, as mentioned above [Eve]. Evan also attributes his development and progress in mathematics at primary school to the individual attention he received in a small school – ‘three to four class groups to one room.’

Both Gayle and Sam recalled getting support with their mathematics homework from their respective mothers, who in both cases could do the primary mathematics, but when it came to second level mathematics – and in Gayle’s case with algebra – they ‘couldn’t help any further.’ Lisa’s mother also helped with her mathematics homework. If Lisa did not understand something, her mother would ‘explain it in a fun way and it made sense;’ she knew from her mother that mathematics was an important subject. In contrast, James got no support at home and felt ‘very much on [his] own’ with mathematics, as his ‘parents found it difficult.’ He was able to get through because he had ‘a very good teacher.’

**Summary**

The public context, meaning doing a mathematics problem or answering a mathematics question in front of others, often standing up, featured prominently in this section (14.7%), with having to stand up in front of peers to answer mathematics problems, especially when the student did not know the answer. The public context also resulted in students going blank in the moment, and in some cases, not knowing the answer meant receiving a punishment, sometimes physical, and leaving a lasting effect on the individual. Some students mentioned ‘times tables’ (8.2%) as a recollection from doing
mathematics at primary school. For some this was positive, and they can still recall their
tables to this day as a result of rote learning; for others, there was a competitive element
in answering the teacher, or where students did not understand times tables, and simply
‘played along’ through and recitation or singing, without being able to contribute in class.
Other topics mentioned (3.9%) included difficulties with subtraction especially carrying,
using fractions, and using bigger numbers, particularly with long division.

Enjoyment of mathematics at primary school (5.4%) was a positive experience for some
students, with enthusiasm, comfort, and enjoyment being referred to. However,
mathematics was not enjoyable where the student had difficulty understanding the
concepts and finding mathematics tough.

Support for the learner (7.5%) was facilitated in a number of ways, particularly with
individual attention from the teacher, as well as small class sizes. Parental support at home
was also significant for those who received it, but not all students had that option.

6.3 Question 3: Tell me about your experiences of doing mathematics
at secondary school

This question continued the flow of talk about mathematics at school, with a focus on
secondary school experiences. While the themes include many aspects representing the
student’s engagement with mathematics at second level, the teacher is treated separately
in section 6.7 – Significant People: The role of the teacher, in order to avoid duplication
of data. Figure 6.4 lists the themes for this question.

List of Themes (percentage mentioned):
- Junior Cycle (6.7%)
- Senior Cycle (8.3%)
- Higher level Mathematics for Leaving Certificate (9.2%)
- Streaming (3.3%)
- Mathematics Topics (5.4%)
- Support (13.1%)
- Punishment (3.3%)
- Contrasts: Primary/Secondary (3.3%), Junior/Senior Cycles (7.2%) Then and
  Now (1%), Ireland/Other Countries (3%)
- Change to Student’s Routine (5.4%)
- Misbehaviour (4.8%)
- Calculator (2.4%)

Figure 6.4 Themes for Question 3 and Percentages mentioned
Junior Cycle

Con recalled that Junior Cycle mathematics was not complicated, but he wanted to get more from it, to understand the context for the mathematics, and it was at that time he noticed it was getting more difficult:

What struck me was the run of the mill, mundane nature of it. There was no effort to engage people in what was really going on, besides the day to day applicable, ... I was a little bit bored in it, wanting to get more from it. ... But it would have been the beginning of finding it a bit more difficult.

Tina was in the higher-level class in Junior Cycle for all subjects, and she recalled doing the Junior Certificate mathematics paper:

First year wasn’t too bad, but it just gets harder and harder. There was a lot of trying to think; the Junior Cert paper I don’t think I answered half of it. There used to be a lot of a breakdown of equations and ... halfway down you’d get mixed up.

She also recalled doing accounts in Business Studies and the frustration at not being able to get a balance sheet to balance:

I don’t think I ever got a balance sheet to balance, I’m like what am I doing wrong. I’d look through it and couldn’t see where I went wrong. It was driving me mad.

However, she failed JC higher level mathematics, and that had a lasting impact on her:

I failed higher maths, so then straight away I wanted to go to foundation [level] but [the teachers] wouldn’t let me, so I did ordinary [LC level]. ... Maybe that scarred me for life, but I don’t like failing things. So that annoyed me but, I just think it got very hard then as well.

Senior Cycle

Gayle’s attitude to doing mathematics changed in fifth year, spurred on by the desire to leave home after school. However, a sense of intimidation in mathematics class due to lack of understanding prevented her from asking questions, which with hindsight she regrets:

Once it hit 5th [year], I was like how am I gonna get out of living here, unless I do well with maths. And I had a different teacher ... he came in, taught and ... you either get it or you don’t. I would have been intimidated, I wouldn’t have put my hand up, because I’d have been one of those students who’d [think] I don’t get that. And we didn’t do that in
secondary school. Whereas, as I’ve gotten older I realise I should have, because it was my education.

Sam remarked that the way the LC mathematics was presented lacked a context and caused confusion:

It wasn’t like why is this; it’s just do it and if you don’t have a full grasp of what’s going on, it’s hard to even remember the process because I found I mixed it up.

James recalled the fear of the possibility of not passing mathematics for the LC:

The weakest subject that I was doing at that time was maths. So, the fear is in relation to the possibility of not passing maths, and at that time maths for some courses at third level was a requirement. I wanted to pass all subjects in the Leaving Cert. … I had a very good [mathematics] teacher, that I reckon combined with some grinds, that’s how I passed.

Lisa commented on the importance of secondary school 12th grade mathematics as an entry requirement for university in her home country of Latvia:

In the 12th grade, there’s a state maths exam. It’s a core subject, and exam in maths is compulsory. That is a really important exam, because every university is looking at the result in maths. A person cannot graduate from the school in Latvia if they didn’t pass maths exam.

**Higher level Mathematics for Leaving Certificate**

For Alec the workload at LC honours level was heavy, resulting in dropping back to ordinary level mathematics:

It was almost like trying to study two subjects because [of] the volume of work and … because I just found the going too hard and I felt that if I was to stick with it, the other subjects I was doing would have suffered as a result, so it was a balance to be struck. But yes, I pulled out anyway.

Con felt that he needed a lot of time to do the work, and wasn’t always confident in his ability:

I felt like I was trying to catch up and never really catching back up, spending maybe an hour and a half, two hours trying to do something, and I’d say it was more by luck that I was getting things to work out, rather than by design.

He continued by expressing a feeling that he was very much on his own doing honours mathematics, and the onus was on him to stay in the honours class:
There was a lack of effective guidance in being able to do it, and there was certainly an attitude at that time in honours maths of well it’s up to you to keep up. And there would have been fairly swift drop off from kind of fifth year into sixth year. ... And the emphasis was put on the student to keep up rather than the teacher to keep as many people in honours as possible.

Con asserted that those doing honours mathematics were doing it because it was necessary, and otherwise it was not worth doing, and he felt the teachers were also of that opinion:

Even from teachers there would have been an attitude of, if you are finding it really hard, you are probably better off going to pass, because everything is straight forward, and it just really lightens your workload, and unless you have to do honours then, it’s probably not worth your while to do it.

He also was aware that about half of those doing honours mathematics had ‘parents who were science or mathematics teachers,’ and therefore had ‘support with honours mathematics.’ On the day of the LC mathematics examination, he took the ordinary level paper instead, due to mental health issues:

I dropped down to Pass on the day. I would have had mental health difficulties at the time, so getting it done at all was an achievement. I think I got a C3 grade, but it wouldn’t have reflected my ability in a pass paper.

The drop back to ordinary level meant a very different experience of mathematics for Alec, in that it was a much easier syllabus, and resulted in success in the LC exam:

Got on pretty well in the ordinary level exam. I think I got maybe A2 or something again like so, it was pretty good result.

Streaming

Kate recalls when foundation level mathematics was introduced, and she was advised to do it, but she acknowledges the culture was different at that time:

I was doing Pass, and the other one got introduced, the Foundation Level. And we were just kind of told just do that, it’ll be easier for you. ... It wasn’t seen as a big deal; whereas now, obviously, it is. But back then we were told, you’d be better off doing that, just in case you fail the Pass maths.

Gayle recalls doing an aptitude test in first year, and as a result she was in the second lowest class because of her mathematics and English, and was aware of this:
It was recognised that you weren’t in the top classes. We were in the second lowest, and we were always in trouble. ... We also would have known that the teachers who were considered better teachers were kept for the higher classes. ... We didn’t put up our hands, you wouldn’t have done that in the second lowest class, ‘cause you didn’t, do you know the way, like everybody went, oh Jesus, would you shut up.

Dan had been put into an honours Leaving Certificate class after achieving an A grade in his Junior Certificate exam. He thought the teacher was ‘boring and ineffective,’ and he did not work at his mathematics. But he recalled the principal coming into the mathematics class one day and telling a number of students – Dan included – to leave and go to ordinary level mathematics:

The Principal came in and he just said right, let’s take a look at your homework, and he started kicking people out. I got the boot and I was told that I could go back into it, but I didn’t bother my arse. I had a full-time job lined up already so there was no point and I wasn’t planning to go to college.

Mathematics Topics

Lynn had great difficulty with theorems, formulas and symbols, and admits that she needs to grasp the meaning behind these in order to understand them:

I remember trying to learn Pythagoras’s theorem. I was so lost that I couldn’t work it out. If it was a normal thing that I could picture in my head even, I could work it out but anything with a formula I don’t get it and I still don’t get it. I don’t get why a kid is asked the Pi or the square root or whatever x plus whatever, I still don’t get that and I don’t get that all they have to do is put it into the calculator.

Her opinion of secondary mathematics was that you did not need to understand it:

You just needed to repeat it and you just needed to get whatever in the test or whatever you know.

Alec also found certain topics difficult:

Things like complex numbers and then differentiation and integration and the formulas for various things and it got a bit more complex.

Pat had difficulty grasping algebra, and could not see the relevance of it:

Algebra was mystery to me. How could you get a letter, there’s a number that’s...And you don’t really use it in day-to-day like you wouldn’t use it.
Lisa referred to the difference between learning algebra and geometry, with the latter requiring more time and effort, which clashed with the demands of her social life:

*I always loved algebra and I wasn’t really into geometry, because at that time more social life came into play and I didn’t have time, because I think geometry is not like something you can just logically figure out. You have to understand it and you have to put some effort in.*

**Support**

Support for second level mathematics was experienced differently by the participants; Gayle did not get grinds, despite her need for extra help with mathematics, as her family could not afford them:

*Maybe those students [in her class] were getting grinds as well, and that’s why they could figure it out, and we wouldn’t have ever been in a position to do that, you know?*

Similarly, Neo came from a single-parent family that could not afford to pay for grinds in mathematics. He reflects on this and the social differences in accessing education:

*One of the frustrating things was I would have gone to a school in a better off neighbourhood where people who went there would be middle class and I would have been working class, and they would have had access to grinds. And it was just a shame. But as you get older, you think of things like should funding inhibit access to education. And ... it does. It makes a difference and an impact. If you don’t have funds to go to a maths lecture or to get maths grinds then you can’t get on as well as other people. ... And it hurt.*

In contrast, James got grinds as mathematics was his weakest subject:

*I didn’t have a lot of help, like I didn’t have any help at home, so I was very much on my own. ... But I had a really good teacher that I reckon combined with I got some grinds, that’s how I passed then.*

He reflects on his need in school for additional help and not seeking or getting that:

*I wasn’t maybe getting enough support, the teachers probably very busy at the time, I probably fell behind. So, I think maybe the fear and the anxiety is just born out of that. But, I think that might have been a crucial time when I probably needed to get more help, and more support with doing maths.*

However, James believes other students had a natural ability with mathematics and did not need extra support:

*My sense is that other students would’ve had probably more ability, maybe more natural ability and might not have needed a lot of teaching.*
He praised his grinds teacher who was able to bring him along:

I would have been there every week, and he was helping me with the homework. He brought me along and ... I had a long journey to get to there. He knew what to help me with and that brought me through.

With hindsight, Jon blames himself for not seeking help with his mathematics:

I suppose the blame is my own, I actually should have looked for remedial help when I was at school, but when you are twelve or thirteen, you don’t think of these things. You are keeping your head above the parapet, and you just say no you are not getting near this at all. But if I did, I wouldn’t have the problems that I have now.

Kate believes her struggle with mathematics was ‘inbuilt’ and something she accepted at that time. She regrets not getting grinds at the time, and acknowledges her parents would have provided for them, if she had needed them, but she was not aware at the time that she needed them or that she could have benefitted from them to stay in ordinary level Junior Cycle mathematics, rather than moving to foundation level.

It’s obviously inbuilt. I knew in my head that I struggled with it, I wasn’t great at maths. It was just like a fact in my head. I don’t know where it originally came from. ... I shouldn't have done foundation [level]. If I had wanted grinds [my parents] would have got them. Without question. But it was like something that didn't even dawn on me. I should have got grinds. I could have pulled myself through the maths, you know. I mean, I didn’t know at the time.

Lisa regrets not asking her teacher for help, for fear of offending her, and she eventually got private tuition in mathematics:

I was too young to go and say something to her because I was thinking that she will take it the wrong way that I’m kind of accusing her in something; it made me feel a little bit worried about maths because we just started to learn geometry and if a person understands basics only then person can understand kind of more difficult things. ... So I was really upset about it but I was too young and afraid to speak about it, ... after that, I took private lessons with another teacher and she could explain it all to me. That’s how I overcome all my difficulties but unfortunately, I did it only in the last year before exams.

Punishment

Jon’s experience at secondary school – and level of engagement with mathematics – was impacted upon by the physical abuse he suffered from his metalwork teacher in first year,
for ‘not having the equipment for class;’ the physical abuse ‘lasted for nine weeks,’ after which Jon ‘did not want to go to school,’ but he did.

Lynn also recalled an episode of physical punishment for getting a mark of 3% in a first-year mathematics class test:

> I remember getting a belt [slap] for the 3% from Sister Bridget. I remember going home and getting a belt [slap] for the 3%. I remember that, and you know if you’re told you’re bad at something, you’ll be bad at it and so I think that didn’t help me, but you see I came from a different time. Do you know, like we got the belts you know? That was part of life.

Lynn’s description presents a sense of acceptance that it was the way things were done at the time, and she recalls being told she was bad at mathematics, which impacted on her engagement with the subject.

**Contrasts**

**Primary and Secondary**

Shay recalls entering secondary school in the U.K. and at that time, mathematics got more difficult, despite him liking it at primary level:

> When I went to secondary school things got a bit harder for me and I think I struggled since. [And] maths was one of my favourite subjects throughout [primary school], but it got harder afterwards. And I wasn’t very good at it or confident or liked it that much. … I was probably 10 or 11. That’s when I found it quite hard and I think my performance went down.

When I asked Shay what was the issue with secondary school mathematics, he replied:

> Simple calculations like adding, subtracting or [multiplication] were more complex due to the fact that the numbers were increased or there’s more to do [and] we got introduced to many calculations, and equations. An example would be trigonometry and Pythagoras’s theorem and I [found] it really hard to grasp them and understand how to work through them using formulas.

**Junior Cycle and Senior Cycle**

Alec did higher level mathematics for the Junior Certificate and tried higher level for the first year of the Leaving Certificate course, and found it challenging, because ‘it took off to a more difficult level.’ Consequently, he dropped back to ordinary level mathematics in his final year.
Gayle did not appreciate the significance of JC mathematics for the Senior Cycle and commented on the difference in her approach to doing mathematics between Junior and Senior Cycles:

*Because we were in a low class, there would have been a lot of messing going on. Nobody really cared what they were going to be doing from first year to third year. I didn’t realise the importance of working at the maths until fifth year, I had to work all the harder to get that [LC] grade.*

Sam’s attitude to mathematics in Leaving Certificate Cycle changed in that he did not put any effort into it:

*I was in the higher level for the Junior Cert, but for the Leaving I dropped down to pass and completely ignored the subject.*

I probed Sam to explain what it was about the Leaving Certificate mathematics that caused him to disengage:

*I was always very confident with numbers but when it came to more abstract concepts, I wasn’t fully grasping the concept behind them, so I felt no confidence in the process of doing it, so [doing] exponentials and logarithms and all, it just became very scary and daunting. And solving equations that don’t actually have numbers in them.*

Dan recalled that the LC ordinary mathematics was like a continuation of JC mathematics, and the syllabus was completed in fifth year, with revision in sixth year.

*It was all at the same level so there was no jump; [if you] paid attention in class you’d pass it. ... I think it was very handy to do the revision [in sixth year] because ... when you do the revision it gets cemented, some of it, into your head. Maybe not for 20 years but it is there some place you know.*

Having done and failed higher level mathematics for the Junior Cycle, Tina did Ordinary Level mathematics for the Leaving Certificate, and was delighted to have passed her exam:

*I feel like it was more similar to the Junior Cert higher level. It was easy in a way because you weren’t really progressing too much more. ... I got a D in the Leaving Cert in maths. ... I think it was always really complicated. ... All them trick questions. ... I was delighted at the time because I just passed it.*

*Then and Now*
Kate commented that it was ‘a different culture’ and she just accepted it back then. Gayle also compared how things were done in her school days with how they are done nowadays if a student needs help with mathematics:

But I know that they do things differently now, you know, they try, if you’re willing to work hard they’ll try, you know, put you with somebody else who might be good with maths.

Jon believes the current ‘project mathematics’ approach is better for students like him that need more words to explain the mathematics.

Ireland and other countries

Ken feels at a disadvantage sometimes in his lectures, as the lecturer may refer to something that was done in the Irish Leaving Certificate syllabus:

There are times when some of the lecturers here will turn around and say, ‘right if you remember the Leaving Cert,’ and I’m sat there thinking, no I never did a Leaving Cert, so I have no idea what you are talking about. And because my education was in the UK, sometimes that’s a big disadvantage.

Mark’s mother-in-law teaches mathematics at second level in Lithuania and commented that the standard of mathematics there was superior to what he was learning in HE:

I asked my mother in law, what sort of stuff are you doing in the last year of secondary school? And she explained what they do, and by the way we didn’t even start that yet in [HEI]. The maths level of Lithuania is much, much higher let’s say than here, it’s sort of easy compared to that.

Changes to the Student’s Routine

Pat admitted to having been a ‘troublesome teen’ and was transferred from one school to another, where he ended up having free classes at the start of the day, followed by mathematics class:

[It] was a difficult transition for me, and the other school, I don’t know did they talk to each other or what’s the story because they threw me straight into French and they expected me to know that. I didn’t have a clue. … So, they just gave me two classes off to study and you know 14, 15, you’re not going to study. You’re just going to feck off home or whatever. … I never done my Leaving Cert, but I done foundation in my Junior Cert, just to get a result because I was struggling so bad.

Pat subsequently found out he had dyslexia, and knows now that help is available for dyslexia, but this was ‘not an option’ for him at secondary school.
Sam had difficulties at home, and this impacted on his school work:

> It wasn’t until probably third year that [mathematics] started to become a bit of a problem and losing confidence in the subject but I’d had home difficulties as well and wasn’t paying as much attention in school and wasn’t probably doing as much work as I needed to be to keep up the pace and ... I was just barely paying any attention to the subject for Leaving Cert.

Jon was absent from first year for six months due to illness. During his six-month absence he missed the basics of algebra:

> I had a serious incident with my health when I was thirteen, I was very, very sick, I was off for six months. And during those six months, the basics of algebra were being presented, and when I went back I had no support at all. There was no way that I could catch up on that, and they didn’t even offer me a chance to try. And I didn’t want to try in fairness, I just wanted to be away.

This experience contributed significantly to his lack of subsequent engagement with mathematics; he passed his Intermediate Certificate exam, and left school after that aged sixteen.

**Misbehaviour**

Alec recalled misbehaviour in his Junior Certificate class as being distracting, but he managed to stay focussed:

> The teacher that I had in the Junior Cycle for higher level maths was a very good teacher but unfortunately there was some messers19 in the class, so she had a bit of a difficult time controlling the greater group, but I still was able to kind of block that out let’s say and just concentrate on the maths.

Gayle recalled being in the second lowest class for Junior Cycle, and ‘a lot of time was taken up with messing.’ Her teacher was ‘an older man, near retirement,’ and she recalls:

> He explained what he needed to explain. And he wasn’t overly bothered whether or not you got it. So those who got it, they were ok, but definitely, we knew we were [in the lowest class], and we were bold as a class. It was frustrating on him to deal with, at times very rude pupils in his late stage of life. I don’t blame him either. But there were times he could get no good out of us. And sometimes I would be included in that bad behaviour as well.

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19 Slang: persons misbehaving
Jon internalised the impact of the physical abuse he suffered by the teacher, and turned to misbehaviour as a way of dealing with it:

*I didn’t tell my parents what happened with me, because I was afraid that they would take the teacher’s side, you know, and I internalised it and I was a bit of a bucko\textsuperscript{20} after that for a few years. But I suppose around sixteen I copped myself on.*

Sam had no issue with his mathematics teachers, but admits he did not dedicate himself to his work:

*I don’t want to say the [teachers] at secondary level were bad because it was just me being a bad student at that time.*

**Calculator**

Sam remarked that if he had been shown how to use the scientific calculator for Leaving Certificate mathematics, it would have been more useful to him:

*They had brought in the calculators for our stage, so again hadn’t been taught how to use them properly but could use the basic functions, I don’t think I ever used it more than you would have used a normal calculator.*

Lynn remarked that she did not know you could put formulas into a calculator to work them out, and this was a far-removed experience from her schooling:

*There was Pi, whatever $x^2$ and I didn’t know you just put it into the calculator. I’ll be there trying to work it out. ... Like on one side I can’t get over how easy it is that you just put stuff into a calculator, but we were never allowed to have calculators in school. I mean I did my Leaving Cert in 1985, there was no calculators, we had to learn it off and work it out.*

**Summary**

With Junior Cycle mathematics some students observed a gradual progression of difficulty levels, and for those who did higher level mathematics for the Junior Certificate examination, they found it helped them with ordinary level mathematics in the Senior Cycle. However, the impact of failing Junior Certificate mathematics can be detrimental to further progress with mathematics. The attitude was more serious for Senior Cycle mathematics, as many students prepared for their final examination, and the prospect of going on to further study or into the workplace, and failure was not seen as an option.

\textsuperscript{20} Slang: A tendency to misbehave
There was an awareness of the importance of mathematics in this regard; however, the syllabus was challenging for some, especially higher level mathematics, which was very time-consuming and content-heavy, with some students feeling alone and without support and guidance doing their mathematics, and in some cases, resulting in students reverting to the ordinary level mathematics class.

The impact of streaming was evident, with students who did foundation level being limited in their future prospects with mathematics. Some students were very aware of being in a ‘lower’ class, which in some cases gave the sense of different treatment of the students. Certain mathematics topics were challenging, including algebra, and geometry, as well as handling larger numbers and equations.

The theme of ‘support’ featured relatively highly among the responses (13.1%), with support being experienced in different ways. Some students referred to their family being unable to afford extra tuition or ‘grinds’ in mathematics, while others could have availed of extra tuition, but did not, and to others, it did not occur to them to seek help with mathematics. Support was also available from some teachers, while some students felt they could not approach their teacher.

For some older students they recall the effects of being physically punished for poor performance in mathematics, or for not having equipment, which was seen to be part of the school’s culture at that time. However, punishment also featured as part of the home life in respect of performance at school.

A number of contrasts featured in the secondary school context; the contrast between primary school and secondary school was in terms of the increase in workload in secondary school; as secondary school there was a contrast between Junior and Senior Cycles, with comparisons being made with Junior Cycle higher level mathematics and Senior Cycle ordinary level mathematics, as well as abstract concepts and more effort being a feature in Senior Cycle. For some students there were contrasts between what it was like back then, compared with nowadays; and among the cohort there were comparisons between the Irish system and the secondary school system in their home countries.

In some cases, a change to the student’s routine, including changing schools, problems at home, and absence from school impacted their level of engagement with mathematics. For some students, misbehaviour in class impacted their learning or the learning of others.
The calculator was mentioned as being an issue with mathematics learning, in that the students were not allowed use one at that time, or they lacked the ability to use it properly to handle complex calculations.

6.4 Question 4: Tell me about your experiences of engaging with mathematics after school

This question explores the students’ experiences after formal schooling. In some cases, the students dropped out of school without completing a state examination, while others did complete their secondary education. Some continued to further and higher education, while others went into the workplace. Figure 6.5 lists the themes for question four.

<table>
<thead>
<tr>
<th>List of Themes (percentage mentioned):</th>
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<tbody>
<tr>
<td>• Mathematics in the Workplace (10.8%)</td>
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<tr>
<td>• Awareness of Mathematics as important (11.9%)</td>
</tr>
<tr>
<td>• Benefit of Mathematics (4.2%)</td>
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| Figure 6.5 Themes for Question 4 and Percentages mentioned |

Mathematics in the Workplace

Alec did an apprenticeship as an electrician, which was ‘a little bit maths based, but not too heavy.’ Dan worked as a draughtsman, and despite doing measurements and scaled drawings, he felt that there ‘was no real need for maths,’ and where mathematics was needed, it was:

... fairly straightforward, Junior Cert maths really. So that’s kind of the level I was working at and of course with the calculator too you don’t need to do too much but anything beyond that no I didn’t really need.

Anna worked with children and did not need to use mathematics:

I worked with kids you know most of the time so the most I would have to do was helping kids doing some homework, but small kids, I didn’t really need to use mathematics at all. So I just left it behind.

James worked in insurance and used a lot of numbers, and remarked that mathematics was important to him at that time:

The first job that I had in insurance after leaving college was working in the accounts department. So that was number based, and that would have been the only other time, after the Leaving Cert that I remember using maths.
Lisa’s engagement with mathematics in the workplace was straightforward, and featured mental arithmetic:

> when I came to Ireland, I started to work in Airport and as a shift leader, I had to do the cash up and cash balance after each cashier, so there I needed my maths. So, because not always calculator can do everything for a person and person has to know how to input things in a calculator. So, it was simple maths, just counting and subtracting and comparing.

Lynn worked in the bank after leaving school and recalls that mathematics was very important:

> I spent 14 years [in the bank] and I certainly needed maths. When I started, there were no computers, we used [a machine] giving people little receipts when they had made a lodgement or whatever, and I had a plug-in calculator which I couldn’t manage without. Then I was promoted to supervisor in head office, and I was doing people’s mortgages. I was very good at practically working out things like insurance premiums and stuff like that, because I could practically go through the thing.

Ken worked in building sites after leaving school and recalls using basic mathematics:

> I’d be like measuring distances and subtracting distances and things like that. There was nothing complicated. I wouldn’t say remedial maths, but you know a very basic maths.

When Mark started working as a builder he also used basic arithmetic every day, but when he went into manufacturing sheds, he realised the importance of knowing trigonometry, but avoided doing it:

> It would have been really useful knowing trigonometry like calculate the angles and that. But I just tried to avoid it as much, because I knew my boss will do it so just you know. And he knew that I’m not good at maths, so I tried to avoid it as much as possible.

Similarly, Neo worked on building sites, and used ‘only the basics.’ But this was followed by a job which renewed his interest in mathematics:

> I got a job working as a chain man which would be an engineer's assistant, and this rekindled an interest in maths. Maybe at a subconscious level. But I decided to try to maybe not have such a limited outlook long term, and it just made sense that engineering was the place I'd like to go.

Pat worked as a spray painter after school, and had to engage with minimal mathematics:
When I left school I worked as a spray painter, panel beater and there was a bit of maths involved, a bit of adding and subtracting but that was towards the end of my time working with them as I was going to the storeroom to mix paint and you had to take small amounts of paint, you had to add them up and I was able to do it, no problem, once I was shown the steps to do it.

Sam worked in a bookmaker’s, which required lots of calculating, but he adapted well in response to the demands of the job:

I was doing quite a lot of maths and calculation with the numbers and my confidence grew with that, really well and I can do it very fast and most of it in my head. ... On a busy day, customers want it back as quick as possible. So, there’s pressure on to get it done as quick as possible. And you have to be able to spot if there’s a problem when you are getting the thing that shouldn’t be that.

Eve ran a bar and restaurant for a number of years and recounts doing calculations quickly in her head:

At night time we had two tills and there’d be six people working, you’d do it quickly up in your head and it would be done.

Awareness of Mathematics as important

After having difficulty with a home project, Dan realised it was a knowledge of calculus that he had lacked in order to advance with his project:

I was building a Trebuchet at the time as a hobby and I did want to work out the formulas for these things, but I could never figure out a maths formula from it. Currently we’re doing something like that and I know now why I couldn’t figure it out, it was differentiation and integration and NT coordinates and ... yeah so that’s way, way beyond what I was capable of.

Mike commented on the importance of mathematics in entering higher education in Nigeria:

The problem in Nigeria is ... mathematics is very, very important and anyone that doesn’t have mathematics won’t be admitted to an institution in Nigeria.

Lisa also referred to the importance of mathematics in her home country of Latvia:

There are three main things [HEIs] are asking, our native language, Latvian then maths and then foreign language is English. So they are three main things that have to be done. Doesn’t matter in which field a
person is going in ... but maths is like a core one which everybody has to know.

Lisa is also very much aware of the significance of mathematics in her future career ‘as a link between engineers and finance people in an organisation.’

Mark acknowledges the importance of getting mathematics right in the workplace, after an encounter with his previous boss:

He tried to explain to me Pythagoras Theory, but it was sort of going through one ear and coming out the other, because I knew he still wouldn’t trust me, because I’m not good at maths. So, and it’s fairly responsible having the calculations right, it was basic, really basic but at the time it was just something like calculating masses and so on.

Neo identified that his lack of knowledge of mathematics made him different to the engineers on site:

Without the maths, you couldn't break into what they were doing.

Neo is aware of the role of mathematics in engineering, and recalls his experience of mathematics in secondary school and not knowing its relevance then:

In secondary school you would have had geometry and maybe not seen the value of it, but having worked on building sites and in engineering offices and seeing real world applications, and studying the complex mechanics behind some of the structures that are irregular, you understand geometry vectors have a part to play in what I am interested in, which is civil engineering.

He continued by explaining how his view of mathematics has changed:

I can see the real-world benefits of it and I can see how someone with strong mathematical skills and problem-solving skills like an engineer can make a living for themselves. And solve real world problems and get paid for it and do what they like. So, my outlook on maths would have changed.

He is aware that competence in mathematics is very important for his work, and he cannot afford to be anxious about mathematics:

I don’t want to feel anxious about maths and I need to be able to get answers that I feel happy with. So that whoever I work for or whatever I do, I can sleep at night without knowing oh, the building might fall down. ... So yeah, maths is important financially and for peace of mind.

James commented on his awareness of the importance of mathematics:
I get knowing how to do maths and knowing the subject and being able to do calculations or whatever was something that was going to be important.

Benefit of Mathematics

Anna commented on the benefit of mathematics in problem-solving in everyday life:

*I think mathematics more than anything just helps your mind to solve problems around yourself. I think that’s the main thing about maths. It’s not only getting a paper and seeing numbers on it. I think mathematics like helps you to solve problems in any kind of situation.*

Because of his interest in and competence in mathematics, Neo was able to teach himself programming, and recalls the satisfaction of that:

*The fact that I had what a real number was from day one and I knew when I started picking up programming that oh, I know what a real number is, and only a real number can go in that box. It helped me an awful lot. So if you have a good understanding of maths it opens up a lot of opportunities to do other things. If you're curious, there're other things you can do with maths and who knows. And even on a personal satisfaction level it's good. Makes you feel good. Smart maybe.*

In contrast, Dan questions the benefit of doing mathematics, if software programs can do the calculations:

*That’s probably a bit demoralising wondering yeah if I do all this maths is it going to be any good to me.*

Summary

Mathematics is seen as important in all aspects of life, including at home, in work, and as a gatekeeper subject to progress in life. But it is important to get mathematics right, and the precision of calculations dictates the effectiveness of work situations which are reliant on mathematics. In work situations there was a reliance on mathematics to be able to do certain tasks, but the extent of mathematics required varied; from basic arithmetic calculations to more complicated calculations and having to process calculations fast. In some situations these individuals witnessed more complicated applications of mathematics but could not engage with it, and were aware that they lacked the necessary mathematical knowledge to do these. Mathematics is seen as beneficial to problem-solving in daily life, but with the prevalence of software to do many mathematical tasks one student questioned if it is necessary to have to learn so much service mathematics in HE.
6.5 Question 5: Tell me about the role of mathematics in your decision to return to HE

This question takes the student back to when they decided to apply for their current programme of study at the respective HEI, and the role of mathematics in that decision-making process. In some cases, prospective students had to update their skills in mathematics, through participation in a preparatory course, or self-study. Others did not prepare for mathematics and regret that decision. However, some students were unaware of the mathematics content within their programme. Figure 6.6 lists the themes for this question.

<table>
<thead>
<tr>
<th>List of Themes (percentage mentioned):</th>
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<tbody>
<tr>
<td>• The Role of Mathematics in choosing a Programme (10.2%)</td>
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<tr>
<td>• Preparation for Mathematics in HE (23.4%)</td>
</tr>
<tr>
<td>o Preparatory Course at the HEI (13.5)</td>
</tr>
<tr>
<td>o Preparatory Course at another HEI (2.4%)</td>
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<tr>
<td>o Self-study of Mathematics (2.7%)</td>
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<tr>
<td>o Not preparing for Mathematics (4.8%)</td>
</tr>
<tr>
<td>• Awareness or not of the Mathematics Content (15.9%)</td>
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</tbody>
</table>

Figure 6.6 Themes for Question 5 and Percentages mentioned

The Role of Mathematics in choosing a Programme

Kate attributes her past experience of mathematics for holding her back from applying to go to HE earlier in her career:

>I always kind of regretted not doing a degree, and it was the maths that held me back. And I was contemplating doing teaching at one stage, and I said I would never be able to do the honours maths.

She recalls the interview with the programme leader and talking about her having done foundation level mathematics. She demonstrated assertiveness towards doing the mathematics and seeking help if needed. However, she attributes her success to luck:

>I said to [course leader], you know, we talked about my maths on the entry level, but he said he’d take a chance on me and see how it worked out. ... So, I mean I've seemed to manage so far. But as I said, I've been lucky.

Since leaving school, Kate had gained experience with a practical use of mathematics, but otherwise avoided mathematics:
I did work in industry. I have some knowledge of charts and stuff, but not actual mathematics. ... So [course leader] said take a chance and we'll see what happens. So, it didn't hold me back. But I obviously just stayed away from that whole side of maths.

Con sat his LC ordinary mathematics examination twice, as he ‘saw it as a stepping stone to get into university.’

Dan did not see the point in working hard at subjects he did not see as useful; he was not going to HE after school and did not work at mathematics as a consequence. However, when he decided he wanted to return to HE, he realised he needed higher level LC mathematics, and needed to work hard, using a number of approaches:

I knew the maths was in trouble which is why I went for the FE thing first, it is a level 5 and there was a maths section in it which was very handy. It started at multiplication, drawing degrees on a circle, and went into integration by the end of the semester which is probably a crazy speed to work at. ... So that was good to do and, I done the honours maths too at the same time and before that I done the Khan Academy.

When Neo applied for the civil engineering programme, he had to do ‘a special mathematics exam as part of [his] application,’ and failed it. He was advised to do the access programme for one year, and subsequently gained access to the degree programme. He attributes his success in mathematics to being proactive about attendance at all mathematics classes:

I've never missed a maths class ... I got through the access course and I opened up my results and ... I knew by my grades that I'd secured a place in civil engineering. So yes, that put a bit of pep in my step.

Neo emphasised the importance of understanding mathematics for his degree, rather than rote learning, and by connecting the mathematics with the more practical elements of his programme:

I knew I would require [mathematics], not just to get the degree but later on in life. To actually understand and not just rote learn, and to be able to identify something over here with something that I've learned in a different module. And maths was the gel that like binds it all together.

Preparation for Mathematics in HE
Preparatory Course at the HEI
Kate attended the HEI’s preparatory summer programme for mathematics, and acknowledged the difference in teaching approaches since her school days:

*I’d done the preparatory maths at [HEI], and that was a help. And obviously I can pick it up. I could follow a lot of it. They obviously have a different teaching approach, I mean, teaching comes on leaps and bounds in that length of time.*

While she found the preparatory course helpful, Kate would not encounter mathematics until year 2 of her programme [in the semester subsequent to her interview]. She intends making a start with mathematics preparation over the summer by doing work on mathematics herself and with the help of the mathematics support centre:

*If I could just tip away at something over the summer, you know, because I mean it’s a big gap for me. But, if I go in there and I see what they say and if I can tip away and maybe I might feel as if I’m doing something about it, I might feel a bit better about it, you know. Try and give myself a head start. I don’t know how much you could do on your own.*

While she has concerns about the mathematics content, she believes mathematics is about repetition, and has confidence having done the preparatory course:

*Hopefully, it won’t be as bad as what I think it’s going to be. But I mean it’s repetition. You have to just repeat it. ... I feel a bit better about it after doing the preparatory maths last year, but see I haven’t used it, really, since.*

Kate did not recall doing BIDMAS in her Leaving Certificate syllabus:

*I didn’t even know about, you know, the BIDMAS, and I do not remember doing that in Leaving Cert.*

Ken was aware that his programme would have mathematics, but did not realise how much mathematics, so he did a refresher course, as he did not understand the terminology in the module description:

*Before I enrolled I did a refresher course because when I looked up the module ... to be honest I didn’t even know what some of the stuff meant. And it was scary, like big words and I’d no idea what this means. I did the summer course, which was helpful in that it got me thinking again about maths.*

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21 Acronym used to identify the correct order in which operations of a mathematical expression/equation should be completed when there are different operations; it stands for Brackets, Indices, Division, Multiplication, Addition, Subtraction (BBC Bitesize, 2017).
Lisa availed of the preparatory summer mathematics course for mature students, and found after one week she was more content about mathematics:

*I attended the preparatory maths course for mature students only for the first week because it was two weeks long and during the first week, I already realised that I was probably overthinking and over stressing the maths and it went really well and I remembered it all fairly easy and I never regretted that I went for it and if I would have a chance, I would do it again.*

Evan was confident about his ability in mathematics, as he ‘had retained day-to-day usage,’ but still did the preparatory mathematics course, which was part of the mature students’ induction course of the HEI:

*I felt it wise to do the mature students’ induction course, which I am glad I did, as it was the equivalent of putting on WD40.*

Jon did the Access course at the HEI, which had two mathematics modules. The help he received at the mathematics support centre made a positive impact on Jon:

*I did the access course here, and Jesus just to go into the classroom I was terrified. And we had a fabulous teacher, and the [maths support centre] here helped me an awful lot. … It was two modules, one was in ordinary mathematics, and the other was in statistics, and you know the language in the statistics isn’t too bad.*

Preparatory Course at another HEI

During an access course the year before he started at the HEI, Dan could not recall how to do long division, and had to learn from scratch:

*The funny thing is you think you remember a lot of it. The reason I done the course there last year was because I wanted to see what level my maths was at and I couldn’t do long division so that was a bit of a shock to the system. Multiplication was fine. I could do it in my head, but I couldn’t write it down, do the 7 and put the numbers above and below, just couldn’t remember how to do it.*

Dan had to do the Leaving Certificate honours level mathematics examination as a mature student to be able to apply for his course. He described that as a ‘shock to the system.’ In the examination he was surprised at the number of LC students that walked out before the time was up; he ‘didn’t see the point of it.’

Self-study of mathematics

Mike has some previous knowledge of mathematics:
In the last 2 years [before this programme] I did some courses like Care Assistant and other stuff, but I still practised my mathematics because I did some examinations for Nursing and that brushed my mathematics up a little.

He subsequently found it useful to familiarise himself with the mathematics through ‘doing practice questions and past examination papers.’

Mark started preparing himself for mathematics the year before he started at the HEI, and spent nine months doing mathematics himself, but he preferred using online videos to reading books:

I used the website Khan Academy, so I used online, because I tried reading the books, but it was just that sort of learning style doesn’t get in my head. I need to see someone giving me an actual example solving it, so a human explanation.

Not preparing for Mathematics

Anna regrets not preparing for her service mathematics before starting at the HEI, but she ‘did not have time.’ Pat was aware that there was a summer preparatory course at the HEI, but it was in statistics, and he did not think he needed it at the time:

It was more statistics and stuff like that, you know it wouldn’t have much to do with what I’m doing now, that’s why I wouldn’t do something like that. It probably would benefit me.

Similarly, based on her past experience of mathematics, Eve did not think she would need to do the preparatory mathematics course:

I didn’t think it would feature, like the workload would be so much. I suppose maybe because we lack a textbook that it doesn’t break it down. I don’t know but I didn’t think that, I wasn’t prepared for the maths at all. I just thought that, okay it’s going to be similar to what I’ve done before, like what else would I need, why would I need it?

She reflects on the downside of not having done the preparatory course, and recommends that prospective students should be prepared:

I haven’t had a positive experience and I think it’s just because I was so unprepared initially. But I would definitely tell anybody that would be coming in to get the head down either do it online or something just to give the extra boost coming here because it is very hard to sit there and you don’t want to ask a stupid question and it mightn’t be silly at all but you have no way of knowing whether it is or not.
Awareness or not of the Mathematics Content

Alec was made aware of the mathematics content in his programme of study ‘during an interview for the programme.’ Anna read the programme description and, while she ‘fell in love’ with the programme, she took a long time to decide if she would apply, because of the mathematics content.

James was aware of the mathematics within his programme, and looked at it as a challenge to himself:

> I suppose I wanted a challenge, like I could have done sociology, I could have done a course without any maths. And you know I could have just sailed through it, but I knew economics and maths was going to be part of the course that I was doing.

Lisa was only aware of the mathematics modules in the first year of her programme, but not of those in subsequent years:

> I wasn’t aware that second and third year involves them also, because they were under different names such as operations modelling. I would never think that operations modelling is maths. So, I wasn’t aware about that.

Similarly, Neo remarked that a lot of the modules in his programme are mathematics in disguise, and he believes that there is a reason for this:

> You think you’ve one maths subject per semester out here, but you’ve actually six subjects and they’re all maths. They’re just called different things. It’s a disguise. So, they don’t actually tell you you’ve six maths modules because people would run away.

Pat was aware that there was mathematics and computing in his programme, and was ‘very, very apprehensive.’ He admits he knew it was ‘going to be a struggle,’ but was aware that help would be available in the HEI. Eve was aware that her programme would have mathematics modules, but she ‘didn’t think it would be as difficult as it was.’

Con commented on the expectation of students coming into a sports health science programme, and having to do science modules:

> Because it’s sport health science, a lot of them are for the most part looking to do physiotherapy or something along those lines. And the science part of it whether it’s mathematics, or physics, chemistry they are slightly surprised that they are doing that, and I’m not sure exactly what they do expect to be doing, but it’s not exactly what they feel they’ve signed up for.
Shay was not aware of the amount of mathematics in his physics modules, and he described that as a ‘shock factor’:

*I was obviously very, very nervous about it because the equations just didn’t make any sense at all to me. And I struggled, I struggled, tried my best to work hard and ... I’ve tried my best and I hope I get a pass in the exam that I did which was mainly calculations, Physics.*

I asked Shay if he was aware of there being mathematics in the remainder of his programme:

*I hope that’s the end of it. I haven’t looked into it too much and I don’t want to either because I think it would scare me. But I think there is not too much maths in [the remainder of the programme].*

I also asked how he would feel if that was the end of his mathematics:

*Very happy. No more nervousness or anxiety as a result of that.*

Gayle recalled signing up to do a sailing course, and did not expect to be faced with mathematics, which posed a challenge for her, and she ended up not completing the course:

*It was all practical. The only thing with sailing, when you were being taught [about] going into the wind, we were taught different degrees. I think you could have got a level one instructor out of it, and I didn’t get it. That involved a bit of mathematical work, it’s not that complicated when I look at it now.*

Jon did not know before he enrolled at the HEI that it included a statistics module, and after commencing the programme he was taken aback when he realised he would have to do statistics, and he tried to change programme:

*When I looked into the course, I found out later on that I’d have to do quantitative statistics, and I said oh Jesus Christ what am I doing? Can I change, and they wouldn’t let me change. I wanted to change back to English and history, not a way, so I got through it you know.*

Lynn was also upset to find that there was a mathematics module in her programme:

*I picked these subjects because I thought they’d be easy. ... When I had my first module of maths in early first year, I cried.*

Tina was not aware of the amount of mathematics in her programme and, while it was a shock to her, she admitted she could have researched the programme content better beforehand:
It was actually a dread when I came to this college and realised there was so much maths because I’d done sports massage before here and personal training and they have nothing to do with maths so yes, it was a bit of a shock to the system. ... No one warned me. I suppose I could have looked better into it myself, but I didn’t. ... You don’t see straight away [quantitative methods] is mathematics.

I asked Tina if she would still have done the programme if she had known about the mathematics in advance:

To be honest yes, I probably still would have done the course, but I would like to have known. It was one of them things like why did no one tell me, so yes, I dread having to do all that now to be honest but I’m sure it’ll work out.

Tina demonstrates a perseverance with the mathematics in her programme but admits she would have like to have been better informed.

**Summary**

These students were very aware of the importance of mathematics as a gatekeeper subject in order to move on with life, either into further or higher education or to get into the workplace. For some, where their intention in secondary school was not to go to HE, there was less motivation to reach high grades in mathematics examinations with more emphasis on passing the subject.

When deciding to return to HE, many of these students did preparatory mathematics courses or engaged in private tuition or self-study. The preparatory courses were viewed as very useful as they helped to re-introduce the students to mathematics and gave a flavour of what life would be like in HE doing service mathematics, including experiencing different teaching methods, and familiarity with staff.

Those who did not prepare for mathematics in advance of starting at the HEI regretted it afterwards, but did not think they would need to do it based on past experience with mathematics. For some, the timing of the preparatory course – during the summer – was problematic; for others the preparatory course focused on statistics, which was thought not to be relevant to their chosen programme.

Most of these students were aware of the mathematics content in their chosen programmes of study. While some viewed the prospect of doing mathematics as a challenge, others were apprehensive. In some cases the names of the modules did not reflect mathematics
content – for example ‘operations modelling’ or ‘quantitative methods’ – and some students did not associate these with mathematics when reading the prospectus. Some students admit they would like to have been better informed about the mathematics content, so that they could have prepared better in advance.

6.6 Question 6: Tell me about the [service] mathematics in your current programme

This question aimed to elicit the students’ experiences of service mathematics in their current undergraduate programmes. These themes represent the issues that are current for the students, in that the students are currently, have recently been or will soon be engaged with mathematics as a service subject in higher education. Figure 6.7 presents these themes.

List of Themes (percentage mentioned):
- The Learning Environment (16.9%)
- Mathematics Content (30.3%)
- Mathematics Assessment and Examination (19.5%)
- Mathematics Support inside the HEI (45.6%)
  - Tutorials (7.8%)
  - Mathematics Support Centre (35.1%)
  - Other Support within the HEI (2.7%)
- Mathematics Support outside the HEI (8.7%)
  - Private Tuition/Grinds (6.9%)
  - Online Resources (1.8%)
- Mature Student and Traditional Student (3.9%)

Figure 6.7 Themes for Question 6 and Percentages mentioned

The Learning Environment

Ken thought he had seen the last of mathematics when he left secondary school, and it was a shock to be back in an academic environment again:

I hadn’t even looked at an equation since I left school, and I walked out of school and my idea of maths was like ‘see you, bye’ you know I never ever thought I’d be back in a classroom situation .. it’s a shock to me you know.

Sam describes his confidence in mathematics at this HEI, and believes it is due to the notes given to supplement the lectures:
They gave you a couple of sentences on the notes of why this is. .. It just makes me more confident with the subject.

Dan described his mathematics lectures, in relation to the duration of the class without a break:

In the last [module] we had 3 hours of maths in a row and that was horrendous. It would be 3 or 4 days before your head was in good enough shape to do maths again which was kind of self-defeating. ... I did wonder was it just me getting exhausted and then you just look around the class and the heads are down.

Eve believes that the number of students attending the lecture – around 500-600 – makes it difficult to ask questions and approach the lecturers, and that this is not suited to mature students:

They [lecturers] have the level 10 in maths like, I would be coming from Leaving Cert level five and I think in some respect they think you know all this but when you haven’t done it in so long I don’t think that they, you know, they don’t see you anyways because the place is so big. So, I don’t think it’s geared so much for mature learners.

Eve also feels the pace of lectures is too fast, and she is not alone in thinking this:

I just find that it goes from zero to 60 and I’ve spoken to a lot of the Leaving Certs from last year, but they wouldn’t have done the higher level and there was some of them that had issues especially with the second semester maths.

Eve adds that it is intense with a high volume of material to get through in a semester:

I just dread if you miss one lecture here I find that it just keeps moving ... so fast and it’s so intense in the 12 weeks; we had the three lectures a week but ... what you go through in the 50 minutes, it’s quite a lot you know.

Eve feels she takes too long to do her mathematics work and needs to approach it step-by-step. She regrets not being better prepared for mathematics:

I wanted to ... take it in steps, you know you don’t get from the bottom of the stairs to the top of the stairs by jumping, but that was a slow way of doing it and then the more time I was spending on it the more time I was falling behind in lectures ... because it was taking me that bit longer to prepare for it. I just wasn’t prepared for the maths.

Alec also comments on the pace and volume of material in lectures:
I wouldn’t really have so much to be asking within the context of the class itself a lot of the time because they just go through so much during that time anyway.

In class Pat needs to calm himself to be able to pay attention:

I’ve to kind of try to calm myself going into the accounting management class just so that I can listen to what she’s saying, what she’s trying to explain and try to take some of it in, you know, instead of just sitting then twiddling my thumbs and saying what’s the point in me doing it, which was my attitude.

Pat acknowledges the expectation of the lecturers within his programme, but feels he would slow down the class by asking questions, and tries not to in order to avoid the disapproval of his classmates:

They expect you to know certain things and I get a real anxiety about slowing down the class, I don’t want to ask too much questions, ... ask a question and you hear everybody like Jesus, Jesus. You don’t know what they’re saying but you know they’re talking about you and that makes it worse.

He elaborates further on this experience:

My mind freezes, and I’ll be like, one second and I have to count it out, you know it’s things like that because she did do the example in class and I just felt every eye in the class burning into me and I panicked big time.

I asked Pat if it was the public context, that sense of putting him on the spot that caused his panic:

Yes and ‘you should know it,’ and you’re like Jesus and I didn’t know, I couldn’t verbalise it, and she was like, she goes ‘write it down’ but even at that you know, I could see the people disapproving. I could see them looking over going Jesus, like that’s junior infant’s class.

Pat described his approach to doing questions by himself, which can lead to confusion, as well as doubting himself:

My first answer, that was probably the right one and then I was like ... trying different ways and you know writing down three or four different answers and then I was confusing myself because I was like, which one will I pick now, and that’s what I found.
Mathematics Content

Lynn was very apprehensive about her semester one mathematics module, but surprised herself at how well she did:

When I had the maths in early first year, I cried. ... I surprised myself that I did okay. I suppose initially I panicked and because I didn’t think I’d be good enough and it was so early in the whole experience that like if it was now, I’d be better.

She reflects that she would approach it differently if she was faced with it at this juncture in her programme:

If I had maths now, okay I might look at it from a different brain to the person next to me as in I’d be trying to make sense of it but I would be better because I’ve taken things on that I have just not understood and I still passed.

Anna found the mathematics in the first semester more difficult than in the second semester:

I think we had more things to cover in semester one, everything was so fast, and I couldn’t really digest the things that were coming. It was a very, very fast pace. So, I found it much more difficult. The second semester, it was a little bit easier. I felt more comfortable then.

She had a lot to get used to and contend with in first year. She accepts that mathematics will also feature in the remainder of her degree programme:

The second year we’re going to have mathematics again. Third year, we don’t have maths, but subjects where you have maths involved like biomechanics. So, I think you are always going to find something which involves maths.

Despite her past experience of mathematics, Kate has had to face some mathematics already within her accounting and economics modules, but will have business mathematics in the next semester, and is apprehensive about that:

So, it came back then to haunt me because now I have to tackle it. ... even now I feel anxious about [business mathematics], how am I going to manage it. ... I've normal addition and everyday maths. But all the other stuff? It's like as if I never did it. So, I feel like a young child who's just going from no maths to doing this.

Con believed the mathematics module title was disguised, and he commented that the students in the class had varying levels of engagement with the module:
I saw that it was titled quantitative methods, which kind of gives a little bit of an incline that they were trying to disguise the fact that it’s maths... from a personal point of view it has been just ticking along, get through it. And then, I have noticed other people in the group would have negative views and experiences [of that] module.

When I asked him to elaborate on why he thought this was the case, he referred to the lecturer’s unenthusiastic approach:

The lady who was giving it, I got the distinct impression that she was doing it out of obligation to a lot of people who didn’t want to be learning mathematics. So, it was zero enthusiasm on either side.

Despite that opinion, he sees the benefit of the mathematics he has been doing:

I’m relatively positive towards it. It’s giving me tools that I’ll use either further on in the course, or in a vocational sense. ... I’m not expecting it to be particularly interesting, or something that will grab my attention rather than just something that will aid in working in that area.

Mike describes the benefit of his prior mathematics experience to the current programme modules, and also the challenges he has with more word-based problems, as his first language is not English:

We are going into it deep in detail and the mathematics I did before is very good for the engineering side of the mathematics, but our present mathematics, is based on word problem. For example, like in trigonometry... if they want to give a question they will write it in words.

Gayle’s experience with the mathematics in the first semester of her programme was instrumental in her deferring her place on the programme after just six weeks:

I asked them to defer it for me, and they said yeah, and since then I’ve managed to get in a tutor who comes to me [once a week] and she’s helping me with that, but I actually think that I might defer it another year. ... I don’t know if I can. I might have to reapply then the following year, but that would mean [partner] is finished completely with college, and I think that gives me a better run with it.

Gayle believes it is possible to pass mathematics, because it is going over material done already, but she lacks confidence in her ability:

I suppose once you nail it, it’s stuff that you’ve seen before. And I suppose, I want to do well, I’d like to do more than just pass.

Mark does not like mathematics lectures unless the content has relevance and ‘can apply in real life.’ He had done a lot of preparation in mathematics before starting his
programme, but found the level at the HEI was quite basic, and is surprised how well he is doing:

_They start like really basics, you know like 2X plus 2X is equal 4X. ... I’m still surprised how easy is the first year, extremely surprised. I thought I was going to be you know like sitting with the geniuses and all that, no. I’m surprised I’m doing that well, and let’s say my wife, everyone is surprised._

Neo commented that there was a large volume of material in each lecture, but he took it on board:

_In engineering maths one the volume of material ... what we’d cover in the access course in maybe two weeks, we were covering the same volume roughly in one lecture. So, there was a huge step up, but that was okay because I wanted it._

Sam’s background working at a bookmaker’s has given him confidence with numbers and that has impacted on his attitude to doing mathematics:

_I’ve been doing well on the quantitative methods and as the year has progressed I’ve gotten more comfortable with it. I’m not particularly worried about the final and just know if I get in enough practice I’ll do okay._

He sees the benefit of the mathematics module to the other subjects, which he has had in tandem during the semester:

_It’s already helped with the physics and chemistry because a lot of the calculations were tripping me up, but as the quantitative methods progressed, those two modules became much easier._

Pat tries to go through the mathematics work at home, but is not sure if he is doing it right and that is a problem for him:

_I try to do it at home as much as I can you know, sit down and go over it because the examples are there on how to do it but again, I would like to have somebody to make sure I’m doing it right. It’s more of a reinforcement as well like ‘you’re doing a good job there.’_

Tina does not find quantitative methods interesting, but she sees the benefit of doing the mathematics together with chemistry and physics:

_There’s quantitative methods and then chemistry and physics help with the maths as well._
She recalls how she felt starting the programme and realising how much mathematics there was going to be and how much she had forgotten:

*I even found coming back to college having to learn how to use a calculator again, I found I actually couldn’t remember half the things. Like it’s funny how easy you forget or if you even learn properly in the first place.*

In trying to grasp the mathematics, Tina tries to visualise the problem and pick out the relevant parts, and this can cause confusion, especially among the more abstract concepts:

*I confuse myself more than anything. ... You know when it’s like someone is driving a car at x speed and blah blah and I’m like oh God, what is it, okay, the car is gone here. So yes, it just confuses me sometimes, most of the time.*

She uses an example from Physics to elaborate further:

*There was a part in the physics and it was like ‘I’ was for current and we were like this makes no sense, I for current, you know. But either way it’s not even like why isn’t it c for current.*

She recalls another example of drawing graphs and getting confused with the X and Y axes:

*We had to do a report recently and I remember we had to do graphs and even now I still get mixed up with x and y, which is the x axis, and which is the y, that sounds so silly, but I still do be like which is which.*

Shay struggled with his first semester lectures in mathematics and physics, and recalls what it was like in class:

*I was so uncomfortable. I nearly had like a thought of like ‘what am I doing?’ because I just didn’t understand it.*

Eve found the transition to third level challenging and the mathematics hard:

*I never had an issue primary or secondary school with maths, but I just think the transition to third level, especially here, I just dread maths. You know it’s just double Dutch to me, especially when you haven’t done calculus or that in such a long time and the level is different. It’s very, very hard.*

Eve had attended another HEI after leaving school, and reflects on the difference in doing mathematics in her current programme:

*I found it much easier to do maths in [other HEI] in comparison to here. I think that they go from zero to 60 here very quickly and I think it’s*
maybe because I came out of school that time that I actually found it easier, but I just find maths here so [hard].

Eve describes the approach to learning mathematics at the other HEI, the resources and the lecturer:

At [other HEI] he gave us the sheets with it in proper English. It wasn’t just formulas and symbols, it was just easier, because at least if you had missed out on something you had the notes and there was an example, but the addition was really the lecturer because he explained it so well.

In contrast, she comments that the mathematics in the current programme is more difficult, and she laments the use of written descriptions to explain the mathematics:

I just don’t understand it to begin with but if it was written in English ... like at the first lecture in the first semester, he’d have some of it written in English and it sounds like we’re learning Chinese here or something. It’s simple but in the second semester there was none really. I found that more difficult.

Eve questions the need for the amount of mathematics in her programme, and feels it takes up too much time that could be spent on other subjects:

I just don’t see the relevance of the standard of what I needed for doing science education, why we need it because we’re not going to be teaching maths. ... It takes away from the chemistry or something else. ... It’s just something that really put me off in one respect, but I did spend an awful lot of time at it where I didn’t spend the time equally over all my subjects.

Mathematics Assessment and Examination

The combination of in-class assessments and examination enabled Alec to pass the module overall. His outlook for the mathematics in the remainder of his programme is positive:

There’s maths in each semester actually and some of it looks pretty horrible but hopefully I’ll be able to pick it up and cope with it a bit better.

Lynn refers to learning off material for examinations, and also makes reference to the assessment component of her accounting module as being conducive to her success:

I suppose a lot I’ll try to learn off. I would have found the accounting more difficult. The fact also that we had a CA [continuous assessment] is a great help. It’s just a great help that my term’s work has some kind of a support, so the CA certainly makes a difference.
James feels that he has not learned a lot about the mathematics he has done in his programme, and believes a different mode of examination could have facilitated the learning better:

> I’ve learnt about how to manage, and how to cope with something difficult. But I haven’t really learnt a whole lot about [mathematics], so I think I would have learnt more if there had been tests along the way where I had to sit down, and they were going towards the 100 per cent for the overall module.

His focus with mathematics has been on passing the module, and he ponders the reason behind this:

> I wanted to pass the maths. But envisaging just having to get the 40, it might have been born out of that fear you know. However, I do think that part of it was just wanting to pass the year, you know I have to pass six modules, what’s the best way I can pass this.

Jon comments on using and liking the BIDMAS approach, but contrasts it with the higher level concepts, which seem more abstract to him:

> I can understand [BIDMAS] and there are no symbols. And that type of maths I can do all day every day, .. we will say a train travelling from one place to another, that’s no problem. But it’s the higher level stuff, and even to this day doing algebra 2x multiply by 3y, I don’t know what x and y represent. Is it 20 something multiply by 30 something equals, I don’t know.

He comments on the exactness of quantitative work and statistics:

> With quantitative you have to be quite exact, you know. ... You are either right or you are wrong. I mean with any question I’m asked on the humanities side, we will say the sociology or English or whatever, I can make an argument about something and deviate from it. You can’t in maths, it has to be there and that’s it.

Ken wonders about the way examination questions are written, and if questions are written to trick the students:

> When I get into the exam room, and what I’m expecting isn’t there, it kind of throws it all out then. I start getting frustrated and agitated. I sometimes wonder if it’s done deliberately. I know it’s not a personal thing, but sometimes it feels like ... why’s somebody having a go at me?

Ken finds examination questions can lack clarity, and can cause confusion:
I don’t find it at times clearly defined. Like putting an equation in front of you, or part of an equation, and it’s just left like that and I’m looking at it thinking what do I do?

He compares this confusion to learning a language:

It’s like you get taught to write English, and then you go into an exam and it’s written in Spanish. It’s like where do I start you know, a lot of the times once I start the problems I find I can actually do them.

Ken wonders about the way examination papers are set, as he feels the questions are written differently to the questions he experiences in a lecture:

I don’t know whether it’s just the way the exams themselves are set out. Because you could be doing something in the lecture room and I can grasp it and be quite comfortable with it. And then when it comes to the exam, I’m looking at things and I’m going, I don’t see what I’ve actually been doing.

Ken seems to have trouble in the examination context:

I’m rushing to get it done, because I’m not 100 per cent confident in what I’m doing. So, anyone who’s going into an exam has a certain level of stress, anxiety. So, if I’ve a two-hour exam, I’m normally finished within about an hour and twenty minutes, and then I spend 20 minutes going over the paper. And sometimes I’ll pick problems up, other times I won’t, … and I get very irritated with myself, and I know I should have done better with the maths.

Ken comments that the continuous assessment approach to examining a mathematics module can ‘give you a kind of a comfort zone, which will make the last part of the module easier.’

Neo found his examinations challenging to prepare for, because of the volume of work:

When I went in to do my first year exams for engineering maths one and two, overly generous is how I would describe the quantity of material that I had to cover. And yes, I would have felt anxious doing my exams.

However, Neo’s attitude to mathematics has changed for the better, and he appreciates the relevance of mathematics, but he believes that mathematics content within his programme is disguised in the naming of mathematics modules:

My outlook on maths would have changed. I know that it’s a tool and it’s a binder. It is everywhere. You think you’ve one maths subject per semester out here, but you’ve actually six subjects and they’re all maths. They're just called different things. It's a disguise. So, they don't actually tell you you've six maths modules because people would run away.
Pat sometimes doubts himself in a mathematics examination and ends up trying to do the question in a number of different ways:

> My first answer, that was probably the right one and then I was like ... trying different ways and writing down three or four different answers and then I was confusing myself because I was like, which one will I pick now you know and that’s what I found.

Shay recalls how he felt approaching his mathematics examination at the HEI:

> I was so uncomfortable, and I was like ‘God, how am I going to pass this?’ but I have to be positive, I have to work hard and try to overcome that and it was a big shock. I didn’t like it at all.

Eve feels that the mathematics she learned in the first semester is largely gone:

> A lot of that has gone already because we haven’t re-used it again and if you don’t recap it, then it’s going to go and I just think I had it in my short-term memory just to get over the exams and it’s kind of cram everything you can get into, you know the extra tutorials at the week before the exams and stuff.

**Mathematics Support inside the HEI: Tutorials**

Anna described how mathematics support at her HEI is also in the form of timetabled tutorials, which are not always possible to attend due to timetabling conflicts. In addition, there are students from a variety of programmes with different needs:

> There are students from second year and other courses as well so it’s not the same thing as I’m doing; there was a student behind me who was doing statistics, for example, and another one doing something totally different from myself, so it couldn’t help.

Anna also comments on the mathematics tutorials available to students, and how they helped her only a small amount:

> When the timetables [matched] it was two hours a week ... and I didn’t get as much help as I needed at the time and I understand there are many people who need help. And the lecturers do their best to help everybody in the class. So, I think it helped a small percentage. I would say in the hour I would have 5 minutes with them.

Alec describes the tutorials he attended, and the benefit of these:

> There’d be maybe about between 10 and 15 people coming into the classes spread around a big room and then you’d have some problems you’d work through as much as you could yourself and then get the
assistance of the person giving the tutorials to help you along as best you can.

He also contrasts the tutorial with the lecture:

It’s a more comfortable environment than sitting in amongst maybe 20 or 30 people in the normal maths class during the semester because sometimes the rooms and the arrangement is quite confined.

Alec advocates the importance of asking for help when you are having difficulties with mathematics:

It’s very important to ask for help when you find difficulties because it can get really frustrating when you’re trying to work through something on your own and it’s just not working at the time.

At that HEI – IoT1 – mathematics support is available to those who are in first year, however Alec joined the programme in year two, and does not attend.

There is maths modules for support but I think it’s more geared towards people in first year and they had already assumed that I had a sufficient standard of maths to skip that.

James decided he would attend all his tutorials, because students were awarded ‘ten percent of their module for attendance’ at these.

Eve was critical of the tutorials in that she felt there was no benefit to attending them unless you had a grasp of what was going on in the lecture:

Tutorials were only 50 minutes long and you’d try some of the questions before you went in but when you had no understanding what went on in the lecture, you’ve no understanding of what went on in the tutorials.

Mathematics Support inside the HEI: Mathematics Support Centre (MSC)

Kate describes how, at her interview for the programme, she knew help was available to her:

When I was interviewed for the programme, [course leader] said to me, I had only foundation maths, ... it could be an obstacle. But I said, look, I’ll try my best and if I have to get help now as an adult, I know that I can get it.

She is aware of the mathematics support centre at the HEI and has availed of the service. She intends going there for advice before she starts business mathematics in the next semester, as she feels she would not be able to do the mathematics by herself. The tutors are able to teach in a simplified way:
I’m sure [tutors] will give me advice anyway. They are very good, and they can teach it. … They seem to have a way to simplify it, they don’t boggle you.

Kate is determined to get help with her mathematics and put in the effort required to get through the module, and intends steering away from mathematics after that:

Even now I’m going to go to the maths support centre and see is there anything I could be doing over the summer. It is a major issue for me. I’ll put the work in. … The long-term plan, I’m probably going to take a HR stream, so I’ll be shifting away from it. So, I just have to try and get through next year.

Jon had a positive experience at the mathematics support centre, but still has issues with mathematics:

I spent a lot of time there and they were very good. And you know they will only show you certain things. I needed to be talked through everything, so that I could even understand. … I tried to force myself, I spent hours going to the maths centre, and it’s like looking at a scribble, that’s all it is to me.

He continued by talking about the importance of empathy for mature students:

It is empathy a person like me wants, you know, and I find that with a lot of people. I was a peer mentor for three years here for the new intake of mature students. And all people wanted was to know how to relax, they get caught up in learning new things to a certain extent. But once alone they are grand, that’s what I found.

For Ken the mathematics support centre has been a positive experience, particularly because they start from his level, and with the basics if necessary:

Questions you might feel a bit stupid or embarrassed about asking in the classroom, you can go to the [mathematics support] centre. There’s two lecturers and they are very much aware of the subjects you are doing and can break it down into basic mathematics terms. When they say five and five is ten, that’s where you start from. Other than that, I’d be lost at times.

Ken had failed his mathematics module and with the help of the mathematics support centre he passed the repeat exam; he refers to the difference between the tutors there and lecturers in the classroom:

I actually failed the maths module in the first semester of the first year, and I went to the mathematics support centre. I studied there for the summer, did the repeat in the August, and I actually doubled my
percentage, because the lecturers there actually had time to explain to you, whereas in the classroom they don’t you know. So, I did find it invaluable, and they are approachable. The only downside to that is occasionally you go in there, and there could be thirty people, and they don’t always have time to get to you.

Ken believes it is best to go to the mathematics support centre more often, and when you need to go, rather than putting it off:

I also learnt over the last couple of years to go there more often, rather than trying to leave everything until the last minute, instead of saying oh I’ll go tomorrow, or I’ll go next week which is I think everyone’s fault.

Lisa also had praise for the MSC and their slow pace:

I [was doing] integration by parts. I liked the substitution method but the one by parts I found it a little bit tricky. So, I just went to them and asked to go slowly through one example and after one I could do them all. I think it’s a great help for students. ... So, for me it was really good experience going to them and I would advise it to everybody and I would go there again myself.

Mike has used the mathematics support centre at the HEI, but comments that most of his friends do not use it because they do not have a basis in mathematics, like he does, and he believes that is very important:

I am good in mathematics ... there are some there that didn’t even go to mathematics before. ... Now they find it’s hard because [lecturers] are not there to help you to start from scratch. ... you have to have a good foundation of mathematics. It’s like you are laying bricks. If you miss any brick from your foundation and you’ve just material on top you will be collapsing. ... That’s why most of the matures didn’t go there.

Evan’s experience of the mathematics support centre at the HEI was very positive:

Brilliant. Saved me a lot of time working things out for myself. Interestingly though, until exam proximity panic, those people who really would have benefitted, didn’t go to it. You see it’s the one-to-one thing and explaining the gaps or misconceptions.

Neo went to the mathematics support centre and attended all tutorials, sometimes going more than once, in order to grasp concepts:

The tutors are very good, especially for engineering maths, which would have been a difficult module because you’re doing a Fourier series and then you’re off doing matrices and then you’re off doing regression lines, so it wasn’t really building on itself. So, I suppose I ended up going to three out of the four tutorials. We only were meant to go to two.
So, I would have just doubled up if I felt anxious on the tutorials, ... which is fortunate that my timetable worked out like that.

Neo complemented the mathematics support centre and went there frequently for assistance with his mathematics, both during his access course, and his degree programme. They had the time and gave him the one-to-one attention that helped address the questions he had:

*The maths support centre was sick of seeing me, I’d say, for a finish because I used to go up there sometimes twice a day with every question you could possibly imagine. ... And I just kept going back for more and more. But they had facilities here to spend more time and to answer any questions that I had, and that helped me.*

He describes his positive experience of the mathematics support centre, and uses the analogy of having a cough and going to the doctor to explain what the mathematics support centre means to him:

*Unlike secondary school, I felt that there was no shame in the maths support centre and there was no one on the clock. ... Any time I would feel anxious, and I would be aware that something has slipped through my fingers, then I suppose it's like a cough. If you leave it go, it'll develop into a big cough and before you know it you won't get any sleep. So, if I can identify there's something I can't grasp myself, then that would be an anxious feeling and it can be solved by going to the doctor, which in this case is maths support centre. Or the tutorials.*

For Neo, if he felt anxious about mathematics, he tried harder and knew he could avail of help at the mathematics support centre, and the fact that it was a free service was important to him:

*So, any time I felt anxious, I just put in more effort and it was easy to do because the facilities were there. Did I feel anxious? Of course, I did. Was it stressful? Yeah, but it wasn't like I had an alternative. There was no barrier like money stopping me from accessing the information. So that's how I would have suppressed that anxiousness and not developed grey hairs or worry or felt that I couldn't face another class.*

Pat relies on the mathematics support centre to help him with his mathematics, but it gets busy and time is sometimes against him:

*I can go [there] which is brilliant, you know she’ll break it down into pieces but she’s only an hour and there could be 12 or 13 people in the class so she’d get you started and she’d come back and see ... if she had the time, she’d sit there one-on-one with you, but there’s not the time to do it.*
Pat has dyslexia, and is allowed a scribe for examinations, but declines this help for mathematics because he considers it ‘added pressure’ on him:

*I want to do the maths stuff myself because I could get a scribe for it, but I don’t want to be sitting in the room with somebody sitting next to me waiting for me to give an answer, so I tend to do them myself. You know I probably should get a scribe but again, I don’t want pressure on me either. I know every exam has pressure, but it’s added pressure.*

Pat is proactive about looking for help, and shows the difference in attitude to when he was in secondary school;

*There is help out there for me, ... and I actively look for it now whereas you know back then [secondary school], free class, hey where are we going! ... It’s going to be a struggle but there’s help there for me.*

Pat would also avail of summer tuition at the HEI if that were available:

*If there was something during the summer that I could come up for an hour or two every week or so, they would prepare me better for it you know.*

While Con does not have difficulty with the mathematics in his programme, he comments that some of his peers do, and they believe support in mathematics is lacking:

*The view of my peers would be quite negative, I think they would feel that there’s not a huge amount of support where people are struggling with it.*

I asked him if he was aware of mathematics support in the HEI, and he responded:

*I think there is, I’m pretty sure it’s been mentioned, but I wouldn’t have interacted with them myself.*

Gayle was not aware of mathematics support at the HEI she attended:

*They didn’t offer any help now cause [partner] said that surely there was some help, ‘cause he would have received help in his first year, and I said no, they didn’t say there was any help for maths with the bioscience.*

When Gayle returns to the HEI she would like there to be mathematics support available, and not to have this facility may deter her:

*If I know for sure then I would [go ahead], because I’d like to hold onto her [private tutor] as well, you know as I said between the two of them, if I can’t, then it’s not for me.*
James went to the mathematics support centre for help but found it was too busy and there was time pressure:

_The maths help room is staffed by students, but they are very busy. It was on during lunch time, so I remember going in the first day thinking there’s a lot of things I need to ask. I realised I’m only going to get a few minutes with this guy, ... so I went away thinking this is not going to work for me._

Eve has gone to the MSC but is not comfortable using the service, for fear of looking silly:

_Even going to the [maths support centre]. I just didn’t know where I start with a problem because I didn’t know ... are they going to teach me or if I go there and say well I don’t understand this and I want you to go over it with me, am I going to look silly by saying that you know. ... I went there a couple of times, but it was just always so busy there._

Dan is aware of the mathematics support centre at the HEI, but does not go there, because:

_I’m kind of a nervous fella, it take s me a while to get used to meeting people and chatting to them ... so you go to the maths support centre, you try to settle down, they’re busy, you want to ask them a question. It’s often difficult to try to explain to them what you’re asking and then they have to try to explain it to you, so that really doesn’t suit me._

Mathematics Support inside the HEI: Other Support

Lynn works on mathematics problems with a friend in her programme:

_I go to [a friend] all the time and you know he will work out the answers and I’ll try and get his answer and if I can’t, he’ll tell me how to do it. So, you know I’ll ask anything, you know I’ve no problem with that._

Tina gets grinds from another student in her class:

_I’m doing grinds now, private ones for the exam, and there’s a girl in our class who is actually really good at maths and she’s only about 19. She even helped me study for both the quantitative method exams and basically what she taught me before I went in I think is how I passed._

Eve would like to be able to ask for help after the lecture, but nobody stays around:

_For just somebody to stay at the background again even after a lecture, because you don’t get everything written down in a lecture._

Mathematics Support outside the HEI: Private Tuition/Grinds

Kate currently gets private tuition (grinds) for economics outside of the HEI and comments that it is like a process:
There is some kind of extended algebra in the economics now in this semester. But I’ll do it with the guy who gives me grinds. And I’ll just have to try and remember, you know ... it seems like a process, isn't it? It's all about sequencing, isn't it?

Since deferring her place, Gayle has been getting private tuition in mathematics. The tutor’s approach is to concentrate on what Gayle will use in her mathematics module:

She said, some of the things you’ll never use, so we’ll concentrate on those, like algebra. In the beginning, she said I was all over the place, with brackets. But now I'm tidying my work up a bit, and that's helping.

She describes how she approaches mathematics problems for her tutor:

When I get the concept of something, she can see that I try and think differently. ... I have to work it out on a rough piece of paper beside her, and she says I see what you're coming at, and I see I’m not completely stupid at maths. ... I feel I'm not giving myself enough of a chance. And that's why I need the tuition.

Her tutor helps her to see the relevance of the mathematics:

The lady who’s helping me is also into horses, I’m into horses, it was something to do with workhorses in the field, these ones are here, and those ones are there, and if you put them together, and if I can see it, like that I get it, I get it a lot better.

She believes she has an issue with multiplication tables:

Going through my multiplication tables, I have it written out for me, and I sometimes get them wrong, there’s something in there ... there’s serious gaps somewhere. I just don’t understand why I can’t figure out some things.

She comments on the differences between her and her tutor:

She’s 20 years younger than me, she does a lot on her calculator; whereas I end up doing a lot in my head. And she says that’s the difference between us. But she said in an exam you’re just expected to put the thing into the calculator to figure it out; you’re not expected to figure it out in your head. Whereas when we were in school, you were expected to know a lot more in your head.

While Pat avails of the MSC help when possible, he is not in a position to get private tuition:

I could get grinds as well outside, but I can’t really afford them with a family and stuff like that, I’d love to sit for a couple of hours and go
through the whole lot, what I need to do, but I don’t have the finances or the time.

Mathematics Support outside the HEI: Online Resources

Dan used online resources for additional help with mathematics.

What I did find useful was the Khan Academy ... he sounds enthusiastic about what he’s doing so that works for me. You do your maths test and you get a reward for doing the bit of work.

Mark used Khan Academy as he preferred seeing ‘an actual example’ being solved. He also prefers YouTube to the textbook as you can search for ‘exactly what you want.’ Similarly, Eve uses a combination of Khan Academy and YouTube videos, as they each ‘go through it step-by-step, and [she] can look over it again and again.’

Mature Students and Traditional Students

Kate compares herself negatively with others in her programme:

Because I've never really experienced anything like that. I can see the gap, like people who have done the maths in Leaving Cert, with the accountancy, the equations, and we have a good bit of maths in economics at the moment.

Dan has mathematics in each year of his programme, and compares his approach to studying mathematics to that of the traditional students in his cohort:

My logic here is the younger students they have found out about girls and drink and that will take up an awful lot of their time. I did look at their results and these are honours students in the Leaving Cert and they obviously haven’t done a stroke. I’ve been picking away, doing my best, so I found it hard but next year it’s going to get worse for them, but easier for me.

He describes his strategy to get ahead with his mathematics:

Over the summer I am going to try to get the basics of integration sorted out in my head. So that will give me some advantage. I think it’s all about picking away at it. Try not to fail anything.

Eve alludes to the time since being at school as being an issue for her, compared with the traditional students, although she remarked that one traditional student she asked ‘also found the mathematics challenging.’
Summary

The student’s experiences of service mathematics in HE to-date comprise different aspects, including the learning environment, the service mathematics modules, support for mathematics and contrasts between mature and traditional students. In the context of the transition to HE the learning environment is challenging for many of these students, in particular with large lectures, fast pace and volumes of materials. Lecturers are seen as inaccessible and sometimes unenthusiastic about mathematics, but there are other experiences of lecturers being supportive and giving context for the mathematics. Mathematics in the first semester was for many fast paced and time-consuming. Abstract concepts are confusing and can be off-putting, especially where a student does not avail of mathematics support and tries to work it out alone.

Having a combination of assessment types in the module is helpful in seeing progress, and takes the pressure off the final examination. However, examination questions can differ from what is done in class and this can cause confusion. Not knowing how you are doing in an examination is also problematic, and can lead to panic.

Some students find tutorials beneficial, offering support in mathematics in a smaller class setting with space for questions and some individual attention. But timetable clashes may not allow attendance at tutorials, and students are missing out. Some students also attend the mathematics support centres at their respective HEIs, and for most students this is of great benefit to them. However, not all of these mature students use it, due to the centre being too busy, or not open when they are free to attend. Some of these students were not aware there was support for mathematics at the HEI – mainly among IoT2 students. In addition, some students rely on peers and friends in the HEI for help with mathematics. Some students also avail of paid private tuition outside of the HEI, whereby the support is on a one-to-one basis and benefits the students’ approach to learning mathematics. However, financial constraints limit this option to those who can afford it. Many of these students use online resources to help with mathematics. These students are also aware of the difference in approach to learning mathematics compared with the traditional students in their cohort.
6.7 Question 7: Have there been any significant people in terms of your engagement with mathematics?

This question asked students about significant people who have had an influence on their learning of mathematics and engagement with mathematics. Most students referred to the significance of the teacher or lecturer, which will be the focus of this section. Other significant people mentioned by the students, such as parents and siblings, as well as friends and HEI staff are referred in subsections (b) and (c) respectively.

a) A Focus on the Teacher\textsuperscript{22}

While the teacher/lecturer was also mentioned in the context of other questions posed to the students, references to the teacher/lecturer have been collated and are presented in this section, to avoid duplication of data throughout the chapter. The theme ‘Effectiveness of the Teacher’ had references to all sectors of education, and with both positive and negative comments. Consequently, these have been presented as such in the subsequent sections. Figure 6.8 presents the themes for this question.

<table>
<thead>
<tr>
<th>List of Themes (percentage mentioned):</th>
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<tbody>
<tr>
<td>• Effectiveness of the Teacher (72.3%)</td>
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<tr>
<td>o Positive Experiences: Primary School (4.5%)</td>
</tr>
<tr>
<td>o Positive Experiences: Secondary School (2.7%)</td>
</tr>
<tr>
<td>o Positive Experiences: Higher Education (14.1%)</td>
</tr>
<tr>
<td>o Other positive Experiences with a Teacher/Tutor (2.4%)</td>
</tr>
<tr>
<td>o Negative Experiences: Primary School (4.2%)</td>
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<tr>
<td>o Negative Experiences: Secondary School (30.6%)</td>
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<tr>
<td>o Negative Experiences: Higher Education (13.8%)</td>
</tr>
<tr>
<td>• A Change of Teacher (6.6%)</td>
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</tbody>
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**Figure 6.8 Themes for Question 7(a) and Percentages mentioned**

Effectiveness of the Teacher

This section examines the data in respect of the students’ positive experiences of their teachers at primary, secondary and higher education, followed by the negative experiences at these levels.

*Positive Experiences: Primary School*

Eve’s primary school teacher had a positive impact on her learning of mathematics:

\textsuperscript{22} For ease of reading, the word ‘teacher’ is used to refer to both teacher and lecturer in themes and section headings.
If I could get her to teach my kids I definitely would. She was just positive, and if you didn’t understand, [she would say] come up here beside me and I’ll explain it to you. ... She made it fun and easy at the same time.

For Lisa the teacher facilitated a positive learning environment for mathematics:

*The teacher was trying to explain maths to us in a kind of fun way, and it made children want to do it and want to understand it.*

She also refers to the ability of a good teacher to ‘bring that knowledge to others.’

Mike recalls observing how – based on his personal experience teaching young children – the teacher can make mathematics interesting if it is presented as fun, and can help with literacy around mathematics:

*If you want them to have an interest in mathematics you have to be making a lot of fun, playing with them, singing the words, dancing or just show different colours, to talk in numbers, to help the language you know.*

Dan comments on the enthusiasm of his teachers in primary school and the impact that can have on the learners:

*I did have good teachers in primary school and they were enthusiastic people and when people have a bit of enthusiasm for their subject you tend to, I don’t know, feed off it maybe.*

Evan praised his primary school teachers for the attention they gave to him in mathematics:

*The primary school teachers in the village school, without their 1 to 1 attention then I would have remained mediocre.*

**Positive Experiences: Secondary School**

Anna recalls an inspirational teacher she had who made a positive impact on her approach to learning mathematics at her last years at school:

*He was very good at explaining things. ... I could understand everything ... he was always asking all the students if they were fine, if there was any issue. He really was committed to make you understand what was going on.*

Similarly, Eve recalled learning algebra in Junior Cycle, and the way in which the teacher explained it made it easy to visualise and understand the problem:
When we started algebra, our teacher said, you bring the x over the bridge and change the sign and it was all done, you could visualise everything. He was very calm and just said think of it a different way. So, if you didn’t understand, visually you understood it after.

Positive Experiences: Higher Education

Evan’s experience of the mathematics lecturer at the HEI has been positive:

*Teaching quality has been very high. The lecturer knows the subject. They can explain questions and they are inclined to do so.*

James recalls the impression his statistics lecturer left on him with regard to learning and interpreting statistics:

*He talked about information that is shown in surveys, he gave an example of what political parties might say. ... And [how] people can present figures to you because it’s a benefit to them, he says look beyond the figures. ... So that’s something that I definitely began to look at.*

Mark commends his mathematics and physics lecturer’s approach to doing mathematics, and contrasts this with the approach of another lecturer:

*I very strongly believe that it’s all down to the maths teacher, how well you will pick up the stuff. We have a very good maths teacher here, and I learn much faster with him, but then for the other subject which involves maths as well, the teacher is just purely here just for the money.*

Sam commends the influence of one lecturer in him gaining more confidence in mathematics:

*I have to say the lecturer [ ] was a definite positive influence coming in here. It wasn’t that long before I started to build more confidence in the module.*

Sam found the notes given in his HE classes were of benefit to his learning of mathematics, giving him more confidence and he ‘felt more comfortable in tackling it.’

The relevance of the mathematics in higher education is of notable interest to Neo:

*Some of the lecturers when they were covering material that would have piqued my interest. Like the stiffness method uses matrices to get rid of differential equations. So, you can analyse a structure. ... That’s the basis of [what] engineers use in analysing structures in the real world.*

Evan qualified as a civil engineer when he was younger, and has great confidence with mathematics, and also commends the lecturer in his current programme:
They can explain questions and they are inclined to do so.

Ken remarked that although the lecturer does explain things, it is not enough for him; he needs to take his time and go back through the material:

In the classroom when they explain things, I’m the sort of person I can’t just get it once. I have to go back and repeat it, baby steps. ... But when I get into the exam room, and what I’m expecting isn’t there, it throws it all out then.

Ken comments that his current mathematics lecturer is ‘very approachable if you have a problem,’ and has good rapport with the students:

She will take time and explain things. ... the other week I stopped [her] and said what do you mean by that? ... And she said well it’s like this when we was in school and I went ah now I get you. ... But she understood, and just took 30 seconds to say it means that. And as soon as she said that I knew.

This lecturer empathised with Ken, being older than other students in the group, and she was able to clarify Ken’s difficulty with the mathematics.

Ken feels it is important that lecturers have a sense of humour when teaching mathematics. His lecturer also teaches the summer course in mathematics for mature students and he feels she has a better understanding of these students:

If somebody can have a bit of a sense of humour, it makes life a bit easier, and she is aware that the older people in the class may not have looked at [mathematics] for 20 or 30 years. She’ll take a few minutes to do the basics and explain it, which I find extremely helpful. ... She runs the summer course for mature students, perhaps it has made her more aware. ... Maybe that’s something that all the lecturers should do at times.

At the HEI Lisa had learned to do matrices a different way to that of the lecturer and showed her work to the lecturer who was fine with it:

I learned to do matrices ... in a completely different way than the lecturer does them but I showed it to the lecturer and he said it will be fine for the exam.

Other positive Experiences with a Teacher/Tutor

Dan recalls having difficulty with the -B formula [finding the roots of a quadratic equation], but was shown by a teacher in the Access course:
He did explain what it was for and he said yeah you can chop this off and you can use it for this part and you can chop the front part off and use it for that which made a lot of sense. You could be reading books all day but until somebody actually says it to you that this is actually useful.

Gayle feels better about mathematics when she can relate it to something relevant; her tutor helps her to do this helping Gayle to ‘get it a lot better.’

**Negative Experiences: Primary School**

Evan recalls being disengaged with school, and the emphasis on not interrupting the learning for the ‘good kids’:

*I was completely disengaged with the academic side of school; the low levels of control at the school facilitated this in part, since the "bad kids" were allowed to do as they pleased as long as they didn’t interrupt "good kids".*

He also recalls the teacher putting him under pressure in front of the class with mental arithmetic problems:

*When I moved up to the headteacher’s class, there was mental arithmetic for us immediately after times tables and you would be put under pressure to answer in front of the class at which I felt naturally anxious and never developed a particular competence in.*

Jon believed his background was detrimental in terms of how the teachers treated him in primary school:

*We were a lower working-class background. And I felt that in school we were targeted by the teachers; we were the people who used to get beat you know. The headmaster when I was in fifth and sixth class, his son was with us in the class, and his nephew and there was never a word said to them. They could do what they liked.*

**Negative Experiences: Secondary School**

Mike had a teacher in his final year in secondary school in Nigeria who was very strict but would emphasise the importance of mathematics and would scare and punish the students. Good results would be publicised, while bad results meant repeating the exam in less time:

*The teachers are so strict. They used to scare us, like if you don’t know mathematics you won’t be able to do anything.*

Mike recalls being punished for being late to his second-level classes, and that has made an impact on him to this day:
If you come late to the class, you will be punished. Yeah there is still discipline. That’s what helped me there. And now it’s what is still repeating.

Evan experienced the negative impact of teacher strikes in Wales in the 1980s:

In the two years leading up to the O levels there were extensive teacher strikes. I was usually in school for only 2 days a week. I believe this affected my maths development. I became less interested in school. My marks dropped to 60 to 70% [from the 90% to 100% range]. I didn’t have a huge liking for the maths teacher. He didn’t especially interact with the class.

Evan noticed a huge jump from O-level to A-level and had the same mathematics teacher at both levels. He described this teacher as having a ‘wooden, inflexible presentation.’:

He may as well have been a video, he had his own performance and script, and saw any questions as a distraction or disruption, and could be quite sarcastic: … [For A-level] he just got more sarcastic; as people dropped out of his class he would sing 10 green bottles as if he was amused by the failure.

Despite a good start to secondary school, with good grades in mathematics, Ken was ‘allergic’ to his fourth-year teacher, and did not attend mathematics class in the last term of his final year, and that teacher had a negative impact on Ken’s attitude to mathematics during and after school:

It seemed all he wanted to do was algebra, like for two years we did nothing but algebra. And I just got sick of it in the end, and I passed the exam, but to this day I don’t know how, because … for basically the whole of the last semester I didn’t go in.

He added that when he left school, he thought he would ‘never see mathematics again.’ I asked Ken to elaborate on what the teacher was doing:

There was just no let-up whatsoever, it was every single day the same thing, and I just didn’t see the point in it anymore. And for a long time after I left school, I had no interest at all because I kept thinking like all maths is algebra, and when I came here we started doing algebra as well, oh no.

The teacher would insult the students if they got something wrong, and the impact of that teacher lasted with Ken:

He would ask someone a question, and if they got it wrong, he would be like oh are you a moron, you know or words to that effect. And I got to the point where I wouldn’t even go into the classroom, which I suppose
over the years did have an effect in that I would avoid maths, apart from what I had to do.

Gayle referred to the ‘better mathematics teachers’ being ‘kept for the higher classes.’ She also recalls being told that some questions they were presented with were only for honours students, and that LC ordinary students did not have to do them:

If there were 20 questions and you’d get to 15, and only those who were really bright could get to pass 15; they got more difficult from 15 to 20. So, those who could manage from 15 to 20, they went on to do the honours. I know, our maths teacher would have said, look, don’t worry about the end ones, you’re not going to get them.

Reflecting on this episode, Gayle believed that these questions were inaccessible to her, and suggested a sense of indifference to low achievement:

It was like you had to bring in some extra intelligence, that I didn’t have, in order to get the last 5 questions. And, it was almost trickery, you know, you got that far, and you thought, that was for honours students. You couldn’t make head nor tail of those ones. … But they were too hard anyway. We were definitely told that was too hard.

Gayle’s teacher for the Leaving Certificate expected the students to ‘get it’ quickly:

He was a bookie as well, he was very good, very quick, but he did expect you to catch on to the information, and if you didn’t he wasn’t interested in staying behind to teach you extra work; he came in, taught and that was it.

Gayle is aware of the difference in education nowadays, and how weaker students or children with challenging behaviour are encouraged and brought along:

I used to work with children with challenging behaviour, and when I think now about how they teach, I think that if you teach somebody a subject, you should nearly ask the students at the end of the class to tell you what they’ve learned, because everyday you can go in and you find out a year later that the students don’t know anything.

Neo commented on the mathematics teachers being there to deliver mathematics, and his sense of frustration at not getting the help he needed:

They were specialist maths teachers, they were in to deliver content for 40 minutes, and on the clock, and they were out the door and there wasn’t really any support service. … The teacher is going to get frustrated if they have a curious child who just wants them to go over it one more time. That’s how I remember it. I remember being frustrated, I
remember the teacher being frustrated. So that was where I came a cropper.

He also referred to the schedule of mathematics classes having gaps during the week, and the disadvantage of this if you had a question:

*During the week there was always a gap of a day or two, sometimes three between your math classes. If you had a question, you had to wait until you could approach the designated math teacher again, which was frustrating.*

To Neo, there is importance in the teacher giving their time to the student, and this was not his experience at post-primary level. The teacher’s approach did not appeal to Neo, and he felt he was losing his grip on mathematics:

*I started feeling at that stage, in first year even, that maths was a subject that was beginning to slip through my fingers, and that was a horrible feeling.*

This feeling, together with a lot of unanswered questions in mathematics, culminated in him not being able to approach the teacher, and he changed his focus to sport:

*That's how I felt in secondary school, I can't go in here because I'm going to have so many questions. He's going to kill me. Or I'm going to ask him to go back two weeks because I'm still looking at this thing at home that I never got an answer to. ... It just wasn't working for me, so I ended up taking up rugby.*

Lisa recalls when her difficulties started with mathematics and believes it was the teacher’s inability to explain that contributed to her difficulties, as well as Lisa not being able to talk about the problems she was having with mathematics:

*In seventh grade I could see that my geometry teacher was really good in her field, but she wasn’t able to explain and that’s when the difficulties started. ... and in the next two years, my problems with geometry were just building up. I was feeling really upset about it, but I was probably too young and afraid to speak about it. ... So, I took private lessons with another teacher and she could explain it all to me. That’s how I overcome all my difficulties.*

Kate comments that she was dependant on the advice of her teachers when it came to doing foundation level mathematics:

*You're going with the advice of your teachers, and I just went with it. I didn't know it was going to be a major obstacle that was going to confront me.*
It was one of Shay’s second level teachers that brought to his attention that he was struggling with mathematics:

*Once one of my teachers was like okay you were really good at maths when you were younger and now you think a lot when you’re answering a question, and I think that gave me the reassurance that, okay, I was struggling.*

In first year, Pat felt that his mathematics teacher did not want to teach him, in order to give more time to the honours students, and would send him on errands, and in hindsight this makes him angry:

*The teacher couldn’t be bothered teaching me. ... I saw it when I left school, you know, what effect it had on me. He never even took me for a class and it was wrong, but when you’re 12, 13, 14, ah it’s great, I have a class off, you don’t look at it as it’s detrimental. Looking back now I should have said, hey it’s your job to teach me. ... He used to tell me go down to the shop and buy some sweets to get rid of me or go down to the yard. ... When I think about it, it makes me angry and frustrated that he didn’t.*

Pat wonders if he gets anxious about mathematics because of the way he was taught:

*When they did teach me, they were asking me questions and I didn’t have a clue what the answer was, and I’d end up counting on my fingers under the table and that doesn’t work, so it took me ages to work something out that would have taken the class seconds, it would take me minutes.*

Tina did not like her LC mathematics teacher, and wonders if you like your teacher does that have an impact on your liking the subject:

*I wouldn’t have liked the teacher who taught maths. He was the vice principal as well, so he was always rushing back and forth and different things. ... If you like the teacher would you like it some more maybe, I don’t know, maybe not or maybe you’re just not good at it anyway.*

Dan recalls a bad impression of his honours mathematics teacher:

*She was sour every time she came in. In the first class she gave out to everybody and you’re there thinking nobody wanted to go to that class.*

He believes the teacher’s enthusiasm for the subject is very important:

*I think it’s all down to the enthusiasm, like if they’re enthusiastic, yeah this is good, this is handy and you’re there thinking, yeah, it must be.*
Con believed that the second level teacher did not give enough support to some students to pursue higher level mathematics:

*I imagine there was quite a few people who were capable of it, if they were given adequate support, rather than, if you are finding it really hard, you are probably better off going to pass, and unless you have to do honours then, it’s probably not worth your while to do it.*

**Negative Experiences: Higher Education**

Ken commented on the fast pace of the lecturer in delivering new material and the difficulties that caused for him:

*She would write the equation up on the board, and there could be 20 different characters in it, I would take my time to write it down properly, rather than scribble it out. And before you are half way through taking it down, she would be half way through the answer. And everyone in the class was going hang on a second, and she just took no notice.*

He criticised her approach as ‘bad manners,’ assuming that everyone is at the same level and can work at the same pace.

Pat also found that the lecturers go quickly through the content, and that poses him problems, as he needs to take things at a slower pace:

*So, loads of numbers going up on the board and you’re going where did he get that number from, because you’re saying in your mind, but you don’t want to ask it, and that goes through my head every class, it’s been like that always. ... I would need to take it back and go step by step. I find they go quick, really quick through it.*

Pat commented further on the pace of one lecturer and the method of practice:

*You have a workbook and they do it on the board anyway, but it’s just the pace that she goes. She’s a real fast talker, you know it’s very structured. We can practice exam questions and she does reinforce that we practice but, if you get it wrong in practice you’re not going to get it right in class.*

Pat remarked that he had three different lecturers/tutors who each had different ways of doing questions and that caused him confusion:

*That was kind of confusing for me like, if they all did it the exact same way but they all had different ways of getting the same answer.*

Pat referred to asking the lecturer for help after class, but that is not a suitable option for him:
I could take a few minutes at the end of the class and she’ll take a look over it and she’ll say no this is where you went wrong on it and that’s great, but she doesn’t have the time to do it all, so you know I could email her and say this is [my] answer, and she’d send me back the answer and that’s grand, but I prefer somebody looking over my shoulder making sure I’m doing it right.

Eve feels that the lecturers are inaccessible, and it is not conducive to put her hand up to ask a question in the lecture hall, but she would like to be able to talk to them after class:

*It’s not designed for [putting your hand up] and especially when you’re in the [big lecture hall] and the lecturer is wearing a mic, they mightn’t always see you either because it’s very dark. I just think that it’s not the place. ... [I’d like] for somebody to just stay [behind] after a lecture, because you don’t get everything written down in a lecture.*

She also believed that there was a miscommunication between the lecturers and tutors in respect of what went on in the tutorials:

*They’re here to deliver the lectures and that’s it because they don’t give any of the tutorials, you know that’s set by, I know it’s in conjunction with somebody else.*

Shay was having difficulty with mathematics and physics and asked the mature student officer if there was help available to students, and he was advised to talk to his lecturers:

*I should get some help from my lecturers but unfortunately, they were all busy so then maybe find someone who can tuition me. But then there was a factor of cost as well. ... So, I looked into it and got some [tutorials]. That helped a little. But the problem is [that I don’t] understand it and I need a lot of time.*

At the HEI Con feels one mathematics lecturer is unenthusiastic and lacks interest in the module herself, and did not respond to one student, despite saying she would:

*She was just there reading through the lecture without really any interest in engaging with the material itself ... like someone who has to teach to a test. ... There would one mature student I’ve talked to who said that he was having difficulties and tried to engage with the lecturer, and she was supposed to get back to him and didn’t.*

Similarly, Ken remarked that the way one lecturer taught certain mathematics topics made it very difficult for him to grasp:

*Certain subjects I just do not understand, like transposition of formulas the way it’s taught by the lecturer, it made absolutely no sense whatever.*
Ken felt at a disadvantage sometimes in his lectures, if the lecturer referred to something that was done in the Leaving Certificate syllabus:

Some of the lecturers here will turn around and say, ‘right if you remember the Leaving Cert,’ and I’m sat there thinking, no I never actually did a Leaving Cert, so I have no idea what you are talking about. And because my education was in the UK, some of the time that’s a big disadvantage.

A Change of Teacher

A change of teacher can have a positive or negative impact on the student. For Con a substitute teacher at second level had a passive approach to teaching, different to what he had been used to, and contributed to his anxiety about the subject:

The lady who came in to fill in was [saying] ‘do that stuff, come back to me with any problems. I’m not going to teach you anything because you’ve done it last year.’ So, that corresponded with a period of quite strong anxiety, and it ended up that I dropped out of what I was doing there altogether.

Eve loved mathematics in Junior Cycle, but experienced a change in mathematics teacher in fifth year, which altered the dynamic for her learning of mathematics:

I loved maths in secondary school especially up to Junior Cert. After Junior Cert our maths teacher was on maternity leave twice, so we had a lot of substitute teachers which I found made it very choppy because it didn’t flow like it had done before because we had the same teacher for the three years.

Mark recalls that ‘it all changed’ when his class got a new mathematics teacher, and he fell behind, depending on ‘copying others’ work to pass:

At year five in Lithuania we start secondary school, and there was a new teacher. And after that first half year, I lost interest altogether because of bad teaching from that teacher. She was rushing through, and I needed more time to pick up things. So, I fell behind, and if you are not getting your basics right, you are not going to be good after that.

He elaborated by giving his impression of the teacher and the classroom:

It felt like a person there just to make money, not really caring about the kids getting their knowledge. And if you ask the problem, there wouldn’t be a lot of explanation, just a few words. And there was an awful lot of testing, like every two weeks you would have a test. And she wasn’t good at her job.
In contrast, Alec commented that it helped him to see how different teachers approached mathematics:

_It kind of helped sometimes as well to have different people to see their approach to it as well. So, it was like a temporary teacher coming in giving grinds towards the end of the semesters which helped quite a bit as well._

**Summary**

The students had varying levels of experiences of teachers contributing positively or negatively to their engagement with mathematics at all levels of their education. Positive recollections included those of primary teachers being positive, fun, and enthusiastic about mathematics, as well as giving attention to the students; at second level some teachers were inspirational and good at explaining mathematics which helped to grasp the concepts; in HE most students have experienced high standards of lecturing and praise their lecturers for teaching styles and for being able to convey the relevance of mathematics to their discipline of study, with humour and empathy in dealing with mature students.

In contrast negative experiences include being punished – sometimes physically – as well as being put on the spot in primary school in front of the others; in secondary school the transition to first year mathematics and again senior cycle mathematics was a challenging step up. Timetabling issues meant a student had to wait days to have mathematics questions addressed. Context was often lacking for second level mathematics which made understanding more difficult. A heavy focus on the leaving certificate examination did not help in this regard. Some students felt a lack of support from the teacher meant students could not do higher level mathematics and missed out on certain HE opportunities. At HE, some lecturers were criticised for going too fast and introducing too much material in lectures. Different teaching styles among lecturers can cause confusion for the struggling student. Lecturers are perceived as inaccessible, and sometimes there is a perceived miscommunication between lecturers and tutors. Students would like to be able to talk to lecturers after class, but this is often not possible. Some students feel there is a lack of awareness of the mature student cohort in the class, and that they are often not considered in what the lecturer says.
A change of teacher can be seen as positive or negative, with positive impact including seeing how someone else can do mathematics, and negative impact being the apparent lack of communication between previous and new teachers.

**b) A Focus on Family Members**

This section looks at the significance of family members in the students’ engagement with mathematics, with an emphasis on the role of parents – individually or collectively – siblings, and partners. Figure 6.9 presents the themes for part (b) of this question - a focus on family members.

<table>
<thead>
<tr>
<th>List of Themes (percentage mentioned):</th>
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<tbody>
<tr>
<td>• Parent (23.1%)</td>
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<tr>
<td>o Father (5.1%)</td>
</tr>
<tr>
<td>o Mother (9%)</td>
</tr>
<tr>
<td>o Parents (9%)</td>
</tr>
<tr>
<td>• Sibling (7.5%)</td>
</tr>
<tr>
<td>• Partner (6%)</td>
</tr>
</tbody>
</table>

**Figure 6.9 Themes for Question 7(b) and Percentages mentioned**

**Parent: Father**

Evan’s father helped him with his A-Level mathematics, and it was the way he explained it that made it ‘click’ for him:

*My father is not especially good at explaining things; however, his maths is A level plus as he studied structural mechanics. It was a frustrating process, however eventually it clicked, and all the pieces fell into place, [using] visual representation of maths.*

I asked Evan to elaborate on how it fell into place:

*Most important was the interaction, when there was something I didn’t get, to stop, and have it explained again, or differently. Only a few pieces needed to be put together and suddenly it all came good. I had the highest mark in A level maths in the school, a B.*

Ken recalls his father being good at mathematics, but not helping him with school work:

*My father was always quite good at maths, but he never really took an interest in our school work. His attitude used to be, I’ll make sure you go to school, it’s up to you to learn. He never really took a great deal of interest.*

Tina felt inferior compared with her father, who was good at mathematics:
Growing up everyone else was always really good at maths. My dad always was really good at maths and then you weren’t as good as dad and I suppose you dread having to do them and stuff. ... My dad would have tried to help but in saying that, I wonder if he had to do them kind of maths would he be any good like.

Parent: Mother

Lisa recalled her mother being good at mathematics and helping her and her siblings by explaining it in a fun way. Her mother’s approach to mathematics left a positive impression on her and her siblings:

Mom was always saying that it’s not as hard to understand it and she was trying to explain it to me in a fun and nice way so in my family also everybody sees maths as important subject and I think so, everybody still encounters it in their lives, so it was an important thing in our family.

In contrast, Kate comments that her mother was not able to help her with mathematics, and she was ‘left to her own devices’ to do the work:

My mother wouldn't have been really able to help me with my homework back then. I used to just do it myself. I mean, with my lads, we sit down, and we do the homework, and I think everyone does that now. Whereas when I was doing homework, it was my own responsibility. There wasn't really help.

Sam said his mother was unable to help him with his mathematics homework ‘since probably sixth class’ due to ‘a lack of ability and she just didn’t do it that much in school either.’

Gayle recalls her mother being very smart, but not having time to spend helping with homework due to family responsibilities at home; she would not have been able to help with more challenging mathematics like algebra:

She didn’t have time because she was rearing six kids on her own. She would have done her LC would have helped to a certain degree. But once it got to algebra and things like that, she wouldn’t.

Neo asserted that parents can help you according to ‘whatever level of maths they've been educated to.’ He recalled his mother not being able to help him with his secondary school mathematics homework, despite her wanting to do this:

If you come from a working-class background, with the best of intentions, your mother's not going to be able to help you with whatever you do in class. My mother was not able to help me with my secondary
school maths homework, even though she would have loved to. So, if you have someone in the family who’s been educated to a higher level then you have that access to that to their level of education.

Neo’s last statement points to the significance of being surrounded by others who have a certain level of education, and that you are then privy to that level of expertise.

Dan recalls his mother working through figures and it would take her weeks to do the accounts manually, and that was her approach and method of doing it:

> My mother used to do the accounts, we had a family business, ... she would spend weeks doing the books by hand even though there was computer programmes around but that’s the way she was going to stick with it.

Evan’s mother is a primary school teacher but she ‘doesn’t believe in parents teaching their own children, as it puts undue stress.’

**Parents:**

Kate’s parents were supportive and would have paid for her to have private tuition (grinds), but she herself was not aware she needed extra tuition:

> I probably should have got grinds as well. And if I said it to my parents they would have given it to me. But it wasn't even a thing that came into my head.

She wonders whether it was her home environment, and there did not seem to be a big emphasis on academic achievement, just ‘passing’ the Leaving Certificate:

> My mother wouldn’t have been able to do it. My father would have been, but he was at work. I just remember I used to do it myself. There wasn't really a focus, academically. It wasn't seen as that much of a big deal. My aim was just to pass the Leaving Cert, and once I had a pass I didn't have to go back.

In contrast, Dan’s home environment had a strong emphasis on academic achievement, but he did not see the purpose in achieving high grades when he was not going on to higher education:

> When it came to maths the parents were very strict, they wanted all As ... I didn’t see the point of it. I still managed all Bs and Cs, so I was happy with that, they weren’t, but you’ve got to have a reason to be working for these As like to go to college but I didn’t.

Lynn recalled being slapped at home for failing a mathematics test and added that she would ‘never do that with my own children.’
Mark recalls his parents talking about ability in mathematics being genetic, and that opinion stuck with Mark for some time:

*The parents were saying it’s all down to the genes, because no one in the family is good with the maths, it’s sort of what’s in my head that I can’t be good with the maths ... my parents had an influence by saying that our family is no good at the maths. I heard a lot of the times that 'you are not good.'*

Neo reflects that he did not have parental support, and contrasts this to others who may have had:

*[In terms of] parental support, ability and knowledge to offer support as regards maths was sadly not there. So that had an impact, I guess, versus someone else.*

Pat contrasts his parents to parents nowadays:

*My mother and father, they tried their best, but they weren’t the best at maths either, so. They didn’t know all the answers like, whereas like I suppose parents these days would know.*

Sam did not have help at home, as his mother was unable to help him, and his step-father would not have known mathematics either:

*He wasn’t in a situation where I could go to him, but he wouldn’t have known either.*

**Sibling**

Dan’s brother works as an engineer, and told Dan he ‘hasn’t used any of it since, any of the maths,’ and Dan thinks this is demoralising:

*You can do it all more or less on SolidWorks or a different programme. It’ll give you the formulas, so you don’t have to really do anything. So that’s a bit demoralising wondering if I do all this maths is it going to be any good to me.*

Gayle’s sister shared an experience of having to use mathematics for her work and found the answer using Google:

*She had to give a presentation to a load of suited people, using percentages, she didn’t know how to do that, and she googled it and there was the answer.*

Gayle explained how her siblings were sorry to hear of her decision to defer her programme, and she was the only one of them not to have completed a degree:
I told [my sisters] that I had left, and they were all very upset for me, cause they all have honours degrees or further, and I’m the only one that didn’t go down that road.

Lynn comments on the contrast between her and her sister:

*My sister would have been streets ahead of me ... and I suppose she set the standard that I couldn’t get to and that influenced me a lot.*

Neo recalls a negative episode when his brother was having difficulty trying to learn times tables:

*One of my memories of maths and negativity would have been that my brother really struggled with maths, and I remember my mother rote drilling times tables into his head and him getting really upset.*

Sam comments that his sister is an accountant, but considers herself bad at mathematics:

*It’s actually ironic because my sister does accountancy, but she thinks she’s not very good at maths, and says the calculator does it all.*

Eve helped her siblings with their mathematics, despite them getting private tuition from an accountant, which did not work well:

*My siblings took grinds outside of school with an accountant, so that didn’t work too well. She didn’t understand how to break it down for a child, so it was left to us older kids to sit down for just a few minutes and just check back over again.*

Partner

Gayle compares herself to her partner. He gets the mathematics, is not afraid of it, and is able to do calculations very quickly, in contrast to her:

*If I walked into a shop and I wanted something, it’s a 30% discount or whatever, something in my head just goes ‘just ignore that, Jesus get away from it’, whereas my partner is very good at maths; he can’t understand why I can’t concentrate on that and work it out, it’s all figures, ... and he gets it.*

She approaches mathematics more cautiously, whereas her partner can calculate quickly and with accuracy:

*My cautious self would go over the figure, whereas [partner] to the tee he’d say that’s 17.57, do you know what I mean. He’s not afraid of it.*

Jon comments that he is able to remember numbers that he might use every day, and his wife is amazed at this, considering his dislike of mathematics:
I had no problem remembering numbers, all my bank account numbers and everything are all in my head. My wife can’t get over this, all my passwords are numerical, and I just bang them off. So, I’ve no problem with the numbers itself.

Mark comments that his wife is very good at mathematics, and helps him in her spare time:

She’s really good at maths, and she was teaching me in her spare time. I could see she didn’t believe that I’m going to make it through the year. And then when I’m getting tests like 90 out of 100, she [admits it’s] not too bad.

Pat has a young child, and is concerned that he will not be able to help him as he progresses through school, but insists he will leave the mathematics homework to his partner:

I’ve a four year old at home and he’s going to big school in September and he’s all excited about it, but I’m dreading second, third, fourth class when he comes home and says, dad could you help me with my maths homework and me going, uh-oh. I don’t want to do that like. ... I’d love to do that, I’ll do all the rest, but leave the maths to herself.

Summary

Many students had positive experiences of parental support with mathematics; where a parent was able to help, they were able to get the message across by helping their child to visualise the content, or by explaining in different or in fun ways. However, where parents were unable to help, it was often as a result of the parent not understanding the level of mathematics the child was at, or not being available to help. For some, the parents seemed to be indifferent to how well they did in mathematics, with the emphasis being on passing the subject. Whereas, for others, there was an emphasis on getting high grades, with failure resulting in punishment for one student. For one student there was competitiveness between her and her father in respect of mathematics and she disliked mathematics as a result.

Recollections of siblings doing mathematics included examples of where siblings struggled with mathematics and required help from a parent, sibling, or someone external to the family, such as a private tutor. In addition, insights into how a sibling uses software instead of relying on mathematics caused one student to be reluctant about the need to learn mathematics.
Some student commented on their partners attitudes to mathematics, which for some, was the converse to their own attitude. For those students who are parents there is an appreciation of the need to be adept at mathematics in order to be able to help with homework, and that is worrying for one student who lacks the confidence to help his child.

c) A Focus on other Significant Persons

This section focuses on the significance of friends and peers, and staff at the HEI, as well as other people’s expectations in respect of the students’ engagement with mathematics. Figure 6.10 presents the themes for question 7(c).

<table>
<thead>
<tr>
<th>List of Themes (percentage mentioned):</th>
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<tbody>
<tr>
<td>• Friends and Peers (4.8%)</td>
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<tr>
<td>• Access Officer/Mature Student Officer (2.7%)</td>
</tr>
<tr>
<td>• Other People’s Expectations (5.7%)</td>
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</tbody>
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Figure 6.10 Themes for Question 7(c) and Percentages mentioned

Friends and Peers

Shay recalls that some of his friends loved mathematics, and others did not; but he admires one friend in particular who went on to do a degree in mathematics:

> It was their favourite subject. It was mine to start with and then it wasn’t, and one of them has degree in maths now and she’s doing really great, she is a maths teacher. So, I admire her because it’s not easy.

Anna recalled a friend who has returned to college as a mature student, and has inspired her:

> I’ve a friend who went back to college after years and did very well in maths and it was good for me to know she was a mature student, and she managed to do this, and it had an influence on me, because I think I can do it too.

Gayle referred to those who were good at mathematics being able to shout out the answer, while others, including Gayle, did not seem to have a chance to answer, but may not have understood where they went wrong:

> People who were good at maths would shout out the answer, but then you don’t ever get to answer that question properly, you don’t get to work that out for yourself, so you fall behind, and you continually fall behind. ... Knowing that I didn’t know them, and standing beside people...
who did know them, they could just reel them off, that certainly is something that sticks out in my mind.

Pat compares how he feels about not being at the same level in mathematics as others:

*It’s easy for most of the class and it’s frustrating because I want to be at that level. I think I deserve to be at that level because I’m after suffering so much for it. But again, being 15 or 16 years old, it gets hard and frustrating.*

**Access Officer/Mature Student Officer**

Gayle recalls the conversation with the Access Officer (AO) at the HEI when she was considering her deferral, and he commented on the influence of mature students on others in the class:

*[The Access Officer] said have you made up your mind, and I said look, it’s not gonna work, and he said we’ll be very sad to lose any mature students because they help us settle down our younger students, because ye’ll always show up, and if they see ye are showing up, it will help some of them.*

She reflects on her decision to defer and on the advice of the Access Officer:

*They were just doing basics like, natural numbers, it was almost like I never saw them before. It was dreadful, because I had. But I’ve said to [partner] since that perhaps I overreacted, which is probably what [AO] was trying to tell me as well, don’t throw the hat at it straight away. But I felt that anxiety.*

**Other People’s Expectations**

Lynn recalls when – while on school placement – the deputy principal told her if she is ‘a business studies teacher [she is] also a mathematics teacher,’ and this frightened her, but she will take it on board if necessary:

*That frightened the life out of me. I will try and steer away from it as much as I can but [while] I’m there, I’ll take on the challenge and I’ll look for help.*

Mark would like for other people to think he has been successful, and for him, success in mathematics is important:

*My goal in life is to make all the people around me proud of what I have achieved. And if I fail this, that will be a big disappointment for myself and for people around me.*

Tina comments that she was always seen by others ‘as being good at mathematics:’
I was okay in primary school and people just expected me to be good at maths and I’ve worked in shops for years and so would have always been around that sort of stuff, but sure tills do everything for you.

She talks about working for her father and the expectation around that:

When I worked for him you don’t use tills, but I’d just use the calculator because they’re always slagging me, like your dad can do it in his head.

She recalls the decision to do higher level mathematics for her Junior Certificate examination, and that it was other people’s influence that made her do it:

I honestly don’t know why I went for it really. I suppose kind people say, oh you’re well able for it, and things like that, and you think to yourself oh, maybe I am but you know, probably not.

Tina wonders why people think she is good at mathematics and wonders if it is because she is good at remembering dates and phone numbers:

If you told me your date of birth or anniversary or phone numbers, I’d be really good at remembering all of them sort of things, but equations and stuff, yeah keep me away from [them] ... so maybe that’s why people think I’m good at things, but I don’t think so.

Summary

For some of these students their friends or peers have been influential in their decision to return to education; while others are very much aware of the difference in ability between them and the others in the class who seem to understand the mathematics. Attempts by the access officer at one HEI to dissuade a student from deferring her programme included reference to the positive influence of the mature student on the other students in the class. Other people’s expectations of how a person engages with mathematics can have an impact on their engagement with the subject; for example if a person is perceived at being good at numbers they may be expected to be good at mathematics in a school context. This in turn can impact upon the level of mathematics you take particularly at secondary school.

6.8 Question 8: What has been/How would you describe your strategy with mathematics?

This section aimed to uncover the strategies used by the students to engage with and succeed with mathematics. For some students, engaging with and succeeding with mathematics is about putting in hard work, and understanding the concepts. However, for
others, the strategy is about getting by in the coursework, with the aim of passing examinations being to the forefront, instead of fully understanding the mathematics content. Figure 6.11 lists the themes for this question.

### List of Themes (percentage mentioned):
- Effort (4.5%)
- Understanding (23.4%)
- Focus on getting an Answer/passing Examinations (14.7%)
- Resources (6%)
- Time (5.1%)
- Attitude (2.7%)
- Support (2.1%)
- Avoidance (3.6%)

**Figure 6.11 Themes for Question 8 and Percentages mentioned**

**Effort**

Alec advocates the importance of effort:

> I suppose it’s just down to graft really. Like doing it repeatedly and so on, it gets pretty boring, but it seems to work anyway.

Kate believes that because she has not been using mathematics, it is necessary to put the effort into learning it:

> I’m good at normal maths that I use every day. I’ve no issue with money or bank accounts or bills. I can budget and all that. But it’s the more non-everyday stuff. I haven’t been using it, do you know what I mean. Until now. ... I have to put the effort into it.

Sam’s compares his strategy for doing mathematics to riding a bicycle, requiring you to try it out in different ways:

> Playing around with it as much as possible. If you’re getting it, okay that’s fine, try and do something else, get comfortable manipulating the formulas and numbers, and that’s how I got into doing a lot of it in my head in the bookmakers. It’s just because I got used to it and it’s like riding a bike, eventually you just pick up more and more ability at it.

Shay believes hard work is required to understand and succeed with mathematics:

> Work as hard as you can, learn the basics first and then if you can apply more complexity of the maths and see if you can understand them and always read more, study more, try to understand things. ... So, you
spend more time to understand and asking questions too, with friends if you can.

Understanding

For Anna, understanding how to do the mathematics is important, and she approaches this by going back to the basics:

I want to get things in my mind. I want to remember things I need, like in the first semester, I needed to know very basic things, that I didn’t really remember, like geometry. I want to understand them and ... be comfortable with them because I know we’ll use it for every module we’ll have.

Anna believes in the importance of learning the basics well, and not doing this may impact on your ability in mathematics at a more advanced stage:

You need to learn the basics to know the next step, [otherwise] you will have a problem in the future. And I didn’t really learn well the basics and then when I got to a more difficult level of maths, I started to have problems and I felt very stressful.

Mark’s strategy is repetition, as much as possible, without leaving a long gap:

I suppose as much repetition as I can, go do it and until you can't get it wrong, and then proceed to the next step. Then I know how to do it inside out, [but] after two or three months’ time gap, I start forgetting.

In a similar way, Ken needs to start at the beginning and go over a mathematics problem a number of times in order to understand it:

I have to keep going back to the beginning and then work my way forward. Eventually it will sink in.

Ken has become aware that understanding the smaller details is important, and while he did not always do this, he has learned to address this:

I have an awful habit of missing out on the smaller things or forgetting them. ... I’ve learned to actually take more notice of that. And it has made a difference, as in it has cut the frustration level down.

In hindsight Ken believes it is important to start mathematics early and keep doing it all through schooling:

I honestly believe that you have to start maths when you are younger, and you have to stick at it. You have to keep that side of your brain working and functioning in maths. If you leave it for a while, your brain just switches off.
Con advocates the need for someone else to help him get beyond a certain point, but also acknowledges that he has to do some additional work himself:

*I would like to improve my general maths skills, but it is relatively difficult to get beyond a certain point without someone who will provide better engagement. Or it may be up to myself to go off and look into whatever mathematicians and their work, … rather than expect that from someone who has to teach to a test.*

Lisa tries to grasp a new topic herself before she sees it in the lecture, and believes that practice is most important with mathematics:

*My strategy is first, doing it myself, then going into the lectures and I don’t really believe in reading maths notes. I believe in practicing maths, so that’s my opinion and my type of learning … but in my opinion maths is practice. We can understand it, but if we don’t practice we won’t be able to use it.*

Kate advocates the benefit of understanding the relevance of mathematics and finds it hard to retain mathematics if she does not see the relevance:

*Even the managerial accounting, I can understand those formulas because I understand why it is behind the scenes. I could talk about it in plain English. But it’s as if I can’t retain it because it doesn’t seem like a relevant thing. I don’t know how to articulate it.*

For Lynn it is important to her to grasp the context in order that she can understand the mathematics:

*I try to understand it. If I can put it into words, I can manage. … Even working out time, say 2.25 hours and I had to change it into two hours and 15 minutes. I still don’t understand that, even though I know that .25 is a quarter and 15 minutes is a quarter of an hour. I understand that but, I don’t understand why do you have to turn it into a quarter of an hour.*

Lynn understands mathematics better if she can visualise it:

*If I can put a picture next to this one or kind of make it real, it’s easier for me.*

Mark likes to be able to visualise the mathematics problem and try to see the end result:

*It helps if I can visualise the end result, or the actual components of the problem. That’s how I like to solve the problems.*

Mark uses mnemonics to help with practical rather than abstract mathematics:
One of the main helps is mnemonics to visualise the stuff, and what I can visualise stays in my head. But if it’s abstract problems, let’s say Physics I can visualise, you know a ball moving and an aeroplane flying, there’s no problem, I remember all that. But the abstract stuff like x’s, y’s and z’s, I can’t. I can’t put it in some sort of picture, so that’s the problem.

Neo believes for him the most important approach to doing mathematics is to understand the concepts:

The key thing for me would be to understand whatever it is I'm doing. ... So, my strategy would be to spend maybe 45 minutes on the question, looking over the material, and identifying areas I don't understand. And the next day I can go in to the maths support centre and see if he can go through one or two examples or answer any really specific questions I have. And once I understand something then I try and find a problem that is in a book that we're not covering in class, [or] an application for it somewhere else.

Neo’s strategy for doing mathematics aligns with that of the approach at the mathematics support centre at that HEI, which is about making you think for yourself:

When you get the answer yourself and it registers. It's some trick they [MSC staff] have. They keep asking you questions. If you ask them, they keep asking you. And they're not giving you the answer, they're just making you think, kind of stimulating your brain, which is great. Because ... if you get something yourself then it's a eureka moment. It works for me.

Neo asserts that his approach to learning mathematics is to address what he does not know by asking for help, and to utilise what he does know by extending his knowledge further:

Identify what I don't understand as opposed to what I do understand, and take out those don'ts, put them in a box, talk to someone until that box is empty. ... And that involves sitting down and focusing, concentrating, seeing what you can do and isolating the don't knows and just trying to get some help. And once you understand them then you're in a greater position to see if you ever need to use them. Because you know what they are then.

Neo describes his approach to learning as one where he has to ask questions in order to understand the concept:

Some people can get stuff if you say it to them, and I was one of those people who just had to query it. I had to be able to query it. And if I couldn’t then I wouldn't believe it and it just wouldn't register with me.

Eve’s strategy with mathematics is to translate it into English:
I try and translate [it], you know when you get a maths book, sometimes it’s written in English and I like to get the English before I look at the actual problems like, calculus. I like to understand what it’s about first before you’re given an example of it and then to go through it. I’d rather just written down plain, simple English and then work forward from there.

Tina’s strategy with mathematics has been to learn it off as much as is possible, rather than understand it. She describes her approach by using chemistry mathematics as an example, where she tries to identify repetitive procedures that can be learned off:

There’s certain sections that everything is the same, say you’re doing Electron configuration and the first five are always the same no matter what you’re doing. So, I’ll just learn that off by heart, I won’t really understand why it is and, I suppose that sounds really bad but I just know that’s where it goes. I find it easier to learn things off rather than to understand.

Focus on getting the Answer/passing Examinations

Con described his approach to doing mathematics in second-level, which involved repetition and checking answers with the back of the book:

It was just keep doing things over and over and see if whatever answer you got matched the one at the back of the book, rather than being confident that you were doing things right.

James was strategic in his approach to achieving the grades he needed to pass his mathematics examination, with attendance at all classes being significant to him:

I decided I would go to all tutorials and lectures. And I get 10 per cent for just turning up to tutorials. Then another 10 per cent for doing online quizzes, and another 5 per cent for doing mid-term. So, I looked at my course, [and] I needed to pass all [six modules], but in one of those I could get 35 per cent if I got 40 in all the rest. And I was fairly confident that I could get 40 in five, so I was actually only aiming for 35 [in mathematics] the whole way along. And if I got more than 35 well then that’s a bonus and I still pass. And before I went into the summer exam, I knew that I only needed to get 12 per cent.

James commented on his approach to doing online quizzes and gaining his grades from those:

There was an equation and a box to put the total. So, there was no marks going for how the equation was put together, so I found online calculators, put the equation in, got an answer, put it into the box, and I got the mark. I went through the whole year doing that.
He reflects on the impact of online quizzes on his learning of mathematics:

*How you actually get there is just as important, and how is that done in an online quiz. Maybe that’s why there’s only a box to say what the answer is. But if there was some way of doing it, I would have learnt more.*

James also took a strategic approach to preparing for his summer examination:

*When it came to doing the summer exam, the lecturer said that herself and the guy who did the first semester had only been teaching this year and last year. So, I knew that I only needed to look at the [last two years’] maths papers to have a fair idea what might be coming up. ... I pretty much knew going into the summer exam, if what I have practiced comes up I’ll be okay.*

James’s strategy in a mathematics examination is to get an answer:

*The strategy is to know as much as I can, to be able to get to the point of providing an answer. ... But if I just knew enough to be able to get to a point of providing an answer, even if that answer wasn’t right, I would be confident that the bit that I knew would be enough I suppose to pass.*

In his mathematics exam, Ken looks at the marking scheme to identify which parts of the questions have higher marks:

*In the exams you don’t have to answer questions in a particular order. So, I look at the marking schemes first, and try and answer the higher value questions to build up a higher mark. And it doesn’t matter if you miss the lower value questions, because hopefully you gain enough with the higher value question. Because of the time limitation, I try and pick and choose, rather than getting myself bogged down and frustrated.*

Ken described the strategy he has learned to take in a mathematics examination:

*Reading questions properly, [because] sometimes they can be very vague, and it can take [a few] attempts before things come clear. And then with other parts of the questions, I can’t make head nor tail of them. ... There’s one tip a teacher gave us here, and it wasn’t in maths, and he said if there’s five things in a question, they are there for a reason.*

Ken’s current mathematics module is assessed by three continuous assessments and that is useful as he can gauge his progress during the term:

*I’m hoping to get above 40 [per cent], off the two assessments. So then for the final assessment, any marks I get off that is just boosting my overall mark. ... Well, that’s the plan anyway, whether it works or not is another matter.*
Pat aims to get enough marks to pass his module overall:

*I know I have a certain percentage already got, 10% but then in the main exam, all you need is 30%, that’s the way I look at it. ... I just need to get 40, the minimum and whatever beyond that is a bonus. I don’t mind, once I pass.*

Eve described how she approached preparing for her previous mathematics examination by cramming:

*A lot of the stuff in the first semester has gone already because we haven’t re-used it and if you don’t recap it, well then it’s going to go, and I think I had it in my short-term memory just to get over the exams and it’s kind of cram everything you and do extra tutorials the week before the exams.*

**Resources**

Alec used the assistance of information technology to help him study mathematics:

*I crossed various websites of maths books and so on and then watched a few videos here and there which is great about the modern information technology. We wouldn’t have had access to that when I was doing the Leaving Cert back in 1998.*

Similarly, Mark used online resources as he could find exactly what he was looking for:

*I would watch YouTube videos over the book, because you could search for the topic, exactly what you want, [whereas in] the book you would be flicking the pages.*

Eve uses online resources to help her approach the mathematics step-by-step

*I find a lot of YouTube videos and the Khan Academy are very good and they go through it step-by-step and the different levels that you’re at and that’s something that you can look at over and over again. ... I try and scribe the video and then go back over it again if I had to.*

Lynn recalled the benefit of having a copy book for calculations at hand when she was working:

*I was on the till for years and then I was doing lending, I had a copy book with how to work things out if I needed it. So that was something that I’d fall back on if I needed that.*

When working with another traditional student, Tina recalls how she tried to work a problem out manually, whereas the traditional student used the calculator:
There was an equation for resistance and I remember it was \( r = \frac{1}{6} + \frac{1}{5} \) and ... the girl beside me was like, why are you doing that and I said do you not have to find like a common denominator and she said, God no, ... you just use a calculator and you put it in and I’m like really? But how can you do that, because that’s a sixth and that’s a fifth, it just doesn’t make sense to me.

Time

Kate’s strategy involves her ‘put[ting] the time into it and try[ing] to memorise it.’

Dan describes his strategy with mathematics in terms of how he allocates time to study it:

I can do about 3 hours in a day because after an hour you’re fairly exhausted of new stuff. So I do an hour of maths in the morning, then do something that’s not maths. Do another hour later on and then in the evening do another hour with a break in between, you know.

Mike believes it is important to understand the mathematics and then to take your time studying for the examination:

I start 4 weeks before the exam, practising the questions over and over, doing a lot of exercises, that’s what used to help me in the exam, but I cannot copy myself on someone that can study things today and crams everything.

Mark tries to do his mathematics homework first if possible as it is time consuming, and he does not want to leave it until later, and perhaps putting it off until another day:

Unless I’m in a very good mood, I would do the maths first, but I suppose I should do the maths first, because by the time I have done the subjects that I like, I’m too tired to start the maths and I’ll just put them to the side. I’ll do it another day, it never happens.

Pat’s strategy is to take his time:

Take my time, think it through. Think of the question, think what they’re asking you. Not necessarily put down every number on the page that you think is right. Think it through, take your time and not rush things.

Kate compares doing mathematics to doing accounting and acknowledges it will take time:

It's like accountancy - repetition, repetition, repetition. But hopefully, doing the maths module, it'll be a gradual, progressive thing.
Attitude

Anna has a positive, ‘can-do’ attitude towards doing mathematics, but in an examination situation she has difficulty remembering how to do the mathematics:

*I try to keep calm and I always think in a positive way about maths, like I never ... say to myself, no it’s too difficult or I can’t do this. I always think, I can do this, it’s not difficult, it’s okay and when I get to the point that I have to do an exam or an assessment everything just disappears from my mind. Everything literally, like I can’t remember how to do things.*

Pat has a different attitude towards mathematics nowadays compared with when he was growing up:

*I realise now that I have to take my time with it, whereas growing up it was ... a free class, you know I didn’t see it as being detrimental for me; and going forward hopefully I will get better at it, just through practice.*

Support

Alec contends that it is important to ask for help if necessary:

*It’s very important to ask for help when you find difficulties because, yes, it can get really frustrating when you’re trying to work through something on your own and it’s just not working at the time.*

Kate contemplates her approach to mathematics in the following semester, which includes getting support at the MSC:

*I might print off some past exam papers and try and get a feel for the course outline, but I’m sure [tutors] will give me advice. They are very good, and they can teach it.*

Jon advocates the help of the other mature students in his cohort:

*A lot of the matures here would get together, and we would help each other out.*

Avoidance

Gayle stated her strategy as being avoidance in any aspect of her life that may have required mathematics:

*Avoidance, you know. I did the outdoor sports; I didn’t need a lot of maths with that. I travelled, it was all basic, did you have enough money to get from A to B. You didn’t need maths for that. Then through the outdoor sports I worked with challenging behaviour. It was basic maths with them. For my business, it’s very basic, but I have an accountant,*
because I’ve no idea how to work it out. ... Just avoidance. I wouldn’t rush into anything with figures.

Jon’s strategy with mathematics has also been avoidance, and that prompted him to enrol in a sociology programme, only to discover that he would have to do two statistics modules:

Avoid it, any chance; the whole course I took here was to avoid maths, and I did a sociology major, ... but when I found out later on that I’d have to do statistics, and I said oh Jesus Christ what am I doing? Can I change, and they wouldn’t let me change. So, I got through it you know. I got a B3 last semester, and a B2 the year before, so I did okay. ... But a lot of that was written work and interpretation, and I had no problem interpreting anything.

**Summary**

Regardless of these students’ experiences with mathematics they have developed and employed various strategies in order to engage with mathematics to the level they desire. Among these mature students there is a significant need to understand each concept in order to grasp mathematics, and this contributes positively to their overall confidence in the subject. Confidence in mathematics allows a student to go further with their interest in mathematics and related subjects.

For some students the importance of effort and trying out the mathematics in different ways is beneficial. For most students there is a need to understand how to do the mathematics which may mean going back to basics and taking it step-by-step. In this regard, attention to the smaller details is important. Being able to visualise the mathematics is important for some students, but this is difficult with some abstract concepts. The importance of being able to ask questions is central to some students’ strategies; however, this is more suited to a one-to-one situation with the lecturer or in the mathematics support centre. Some students need to write out the mathematics in order to understand it in plain English. Others resort to learning off certain topics, rather than understanding them, especially where there are repetitive procedures.

Where a student is driven to focus on passing the examination, there is an emphasis on getting the answer, which may necessitate using repetition to get the desired answer. For some service mathematics modules, there are many components that contribute to the overall mark awarded, and being strategic with these can benefit a student, particularly when they are struggling; for example getting marks for attendance or doing online
quizzes, despite admitting there is no real learning with online mathematics quizzes. Some of these students resort to answering examination questions with higher marks first, in order to maximise their potential in the examination. Where there are a number of continuous assessments in a module this is helpful to the mature student as they can see their progress and get feedback during the module.

These mature student resort to a variety of textbooks and online resources to help with their mathematics. There are mixed opinions on using a calculator, with some students not knowing how to use one to its full potential. There is an awareness that mathematics takes time, and these students give time for mathematics. A student’s attitude to mathematics can help in determining how they approach mathematics, especially in examination contexts. Support also features as part of some strategies, and is sought in various ways. For two students their preference has been to avoid mathematics in any aspect of life to-date, and having to face mathematics in HE has meant one student overcoming obstacles, and for another student deferring the programme.

6.9 Question 9: Do you think mathematics will be part of your future?

This question aimed to investigate if the students believed mathematics would feature in their future careers. While there were varying responses, two sub-themes emerged; the importance of mathematics for career prospects, and the intention to avoid mathematics in the future (Figure 6.12).

<table>
<thead>
<tr>
<th>List of Themes (percentage mentioned):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Mathematics as important in the Future for Career Options and Prospects (11.7%)</td>
</tr>
<tr>
<td>• Avoidance of Mathematics in the Future (3%)</td>
</tr>
</tbody>
</table>

Figure 6.12 Themes for Question 9 and Percentages mentioned

Mathematics as important in the Future for Career Options and Prospects

At this stage in his programme, Alec can see that the mathematics is engineering related, but he does not see himself using much mathematics every day in his future at this point:

*I’ll probably be using it from time-to-time but maybe not every day. It’s definitely leading on towards the engineering side of things. There are times where we’re going to have to calculate … by certain methods. I haven’t experienced it in a deep way just yet but maybe down the line it may happen.*
Anna sees the benefit of mathematics in helping to problem solve and can see herself using mathematics in her future career:

*The course is all about mathematics so when I finish this course and I go to a company I think you have to have a knowledge of mathematics. [It] helps your mind solve problems. ... It's not only getting a paper and seeing numbers on it. I think mathematics helps you solve problems in any situation.*

Lisa sees mathematics as very important to her future career in technology management, and is aware of the role she may play within an organisational structure:

*One [role] of the technology manager is the link between engineers and finance people in the organisation. So, we have to understand finance side of an organisation and if we work on a production line, we still have to be able to use formulas; so, [I think] maths will be quite important after graduating.*

Mark wonders about the relevance of his coursework to the real world and the engineering profession:

*Everyone who's doing engineering is saying that in real life they only use five per cent of [what] they have learned in college. 90 per cent goes in the bin, so I know if I’m going to manage with the maths through the year two, I’ll be okay for the year three, year four and the rest of my life.*

In contrast, Neo has a very clear view of the importance of mathematics to his future career as an engineer, and he wants to make sure that what he learns at the HEI will be relevant to his career; he uses the example of a building falling down and the resulting grief he might get as a consequence:

*Maths will play a really big part in my career, and it's important that I just don't have notes from third level that I pull out, but that I'm actually able to use, and feel comfortable with them. ... It's as important, maybe, as a doctor; if you put up a building and it falls down you're going to have a lot of grief.*

Sam believes he will use mathematics in his future but not to the extent he has been doing it at the HEI:

*Probably not to the difficulty that we’d be doing it in college because ... being in sports rehab I’ll have to be measuring proportions and that and calculating body fats and be comfortable with those kinds of formulas.*
Shay believes mathematics will feature in his everyday life, and as a result he wants to be good at it:

> I think so because obviously in finances, figures, numbers, ... it’s going to be a big, big factor for the rest of my life hence I want to improve it

Tina believes mathematics is going to be part of her future and reflects on the way in which she has been learning mathematics:

> Do you know the way sometimes maths has a meaning behind it? I sometimes don’t tend to learn what that is. I learn just what I can see and where it goes, so it’s probably not a good way to learn maths because I’m sure when I go to have to do it in the future for myself, it’s going to be a disaster.

When I asked Tina if she thought mathematics was going to be an important part of her career, she replied:

> Yes, unfortunately, probably is. I suppose because it makes sense when they’re trying to explain the QM that it’s going to be a thing you have to know, if you’re going to be working with people and you’re going to have be doing probabilities of things.

Con sees mathematics as a useful skillset for his future:

> It’s not something that will excite me, or grab my attention, but it will be useful just a skillset that will be of use in the future.

Pat would be happy not to have to use mathematics again in the future, but he is aware that he will come up against mathematics during his career in hospitality. His outlook, however, is positive, and if he has to do mathematics he will try it:

> If I don’t come up against it, it won’t bother me. ... I’m going to get the job in hospitality, it will be in everything that I do, you’re going to use maths and I just have to get on with it. That’s the way I look at it, I don’t like it, but I have to get on with it.

Avoidance of Mathematics in the Future

Jon has a clear view on not wanting to engage with mathematics in the future:

> I’ve no wish to, I’ve no wish to, and why would I at fifty years of age.

Eve does not envisage mathematics as part of her future:

> Absolutely not, if I can avoid it. I’ve never really needed to use it, and I think we are all so reliant on the internet now and calculators that we don’t need to use it as much. ... [My experience] hasn’t been very
positive and because I started off a [bit] behind everybody else, I don’t think I ever fully caught up.

Kate does not want to engage with mathematics after she has finished second year:

The long-term plan, I'm probably going to take a HR stream, so I'll be shifting away from it. So, I just have to try and get through next year.

Although James sees mathematics as important, he expressed a reluctance to engage with mathematics in the future and would rather get help from someone else:

It’s probably important for myself. ... If the day came where I suppose maths was a requirement, if I needed to be able to know it, I’d probably ask somebody to do it, or get somebody to do it, or even pay somebody to do it.

Summary

While the majority of these mature students view mathematics as an important subject, not all of them see it as important for their future careers. Most of these students believe they will use mathematics in work contexts, and some students struggle to see the connection between what they do in service mathematics modules and their future career paths. However, those who do see the relevance have a sense of enthusiasm about the role of mathematics in their careers. In contrast, a few students do not envisage that mathematics will be part of their future and do not want to engage with mathematics after their programme has completed.

6.10 Question 10: What theme would you use to characterise your relationship with mathematics?

This question was the last one of the interview and gave participants the opportunity to reflect on their relationship with mathematics, having already talked about their engagement with mathematics during their lives. Figure 6.13 presents the categories of life themes or characterisations of the students’ relationships with mathematics.

<table>
<thead>
<tr>
<th>List of Themes (percentage mentioned):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Universal Significance of Mathematics (4.2%)</td>
</tr>
<tr>
<td>• Symbolic/Metaphorical (6.3%)</td>
</tr>
<tr>
<td>• Feelings (6%)</td>
</tr>
<tr>
<td>• Clarity of Mathematics (1.5%)</td>
</tr>
<tr>
<td>• The Journey with Mathematics (8.4%)</td>
</tr>
</tbody>
</table>

Figure 6.13 Themes for Question 10 and Percentages mentioned
Universal Significance of Mathematics

In these responses mathematics is characterised as universal, awe-inspiring, part of life and logic, a subject to be respected:

Mike

For me, oh, mathematics is everything. Because everything is about calculation. If you want to drive you have to calculate. If you even want to eat you have to calculate. If you are using a laptop you are calculating. ... It’s in everything, like the Egyptians or history that I read it tells me we all know something about mathematics, everything they did is calculation. Look at the pyramids, it’s been calculated.

Lisa

In my opinion, mathematics is really kind of one of the milestones of our logic. So, I would have to call it in a name, a confidence builder, in my opinion.

Sam

A begrudging respect. Because some of it is very hard but I do understand its importance and as my confidence is growing. I’m liking it more and more again almost to the primary school level but not quite yet but there is the I know it’s going to get harder and there’s that slight apprehension but that’s only normal with every other subject as well.

Symbolic/Metaphorical

These participants used metaphors or symbols – including Mount Everest, something parked there, a necessary evil, divorce and reunion – to characterise their relationship with mathematics:

Kate

Mount Everest, it's a challenge, I know I am going to have to work hard at it. It's not going to come naturally to me. I'd be more worried about those maths-based sections of my subjects than the others. ... Once I know that's there, it's just like a red flag. I understand I have to work at it. ... I'm just trying to confront it.

Gayle

Something that's parked there, and you have to dabble with it now and again to get through, but it's just something that I don't embrace and it's something that I avoid; and I suppose the more you keep it away, the further it gets. But I'm trying, [and] I wouldn’t have the same confidence as somebody else working with figures. I don’t have that confidence unless it’s absolutely right,
Ken

It’s a necessary evil ... I’ll get to a certain level in maths and that will be it, and I don’t think I’ll ever be totally comfortable with it. It will always frustrate me, and I’ll always be wary of certain aspects of it, because I don’t understand it. ... A necessary evil: I do it, I do what I can with it, but I’m never going to be a shining star.

Neo

It was like a marriage that broke up and got back together. I took it for granted for a while when I was younger, and then we parted terms and it wasn't amicable. ... I had a divorce. And we missed each other, and after a few rendezvous with other areas of my life, we got back together, and are looking forward to a bright and prosperous retirement together, so it's onward and upward.

Feelings

These participants used feelings – including hate/love, fear and terror followed by a liking, terror, and dislike – to characterise their relationship with mathematics:

Anna

It’s a hate and love relationship definitely, ... when I get to complete an exercise and especially when it’s a hard exercise, I really get excited. ... When I see something really complicated and then I go through it I just feel oh that’s good. ... But when I am in the class and the lecturer is explaining everything and I don’t understand and then I get home and I try to go back to this thing and I don’t understand, that’s where I feel, okay, I hate it.

Jon

I've developed a liking for numbers, I really have, but in early years my god, oh the only way I characterise the early years is fear, terror. And I suppose it wouldn’t be fair to say the maths was terrorising me, it was the system terrorised me. And maths is the catalyst on my mind, this is the thing that’s causing me all my problems. So, I just avoid it.

Lynn

Maths is the [subject] I would be most terrified of, but I’ve been throwing myself out there to challenge myself, so I’ll take it on if I have to. I need it to make sense. I need it to be practical. ... A bit of fear and just trying to make sense of it, just trying to work it out. I don’t get a lot of it. I don’t know why you’d be able to get a Pi of something?

Pat

I don’t like them, and they don’t like me. ... I’ve never got the maths bug you know.
**Shay**

*I like maths and I would like to understand it, but I don’t think maths likes me very much because I can’t and don’t understand the ideology behind it, so overall, it’s a struggle really.*

**Clarity of Mathematics**

Dan appreciates the clarity in mathematics and the significance of getting an answer:

*I always kind of liked maths anyway just because you get an answer. So, I thought it was kind of easier than a lot of the other subjects, maths is like, 7 is the answer. So, I like that. You’ve got a clear goal and a clear method of doing it. … For the most part I’ve had pretty good teachers so that always helps.*

**The Journey with Mathematics**

These participants characterised their relationship with mathematics in terms of how that has evolved over time. Being away from education has been detrimental to Anna, Con has gained an appreciation of the wonder of mathematics over time, perseverance has been important to Evan, James feels he has not reached his full potential in mathematics, Mark needs to see the relevance of mathematics, Tina sees mathematics as a means to an end, and Eve is frustrated with mathematics now, despite having positive experiences at school:

**Alec**

*I’ve made the best of it when I can and get help where possible, but I definitely have missed the gap in years being in the environment that’s for sure yes. … It would have probably been about 16 years. In terms of finishing and restarting full time education.*

**Con**

*Two words, wonder and frustration. … Something that I find extremely interesting and engaging. … And then thinking back to my own engagement with mathematics, and just looking at a piece of paper, wondering what to do with a sequence of numbers or figures. And just feeling the tension building around your head, and that headache coming on, and frustration and if I could change that to be something far more positive, that would be something that I’d quite like to do.*

**Evan**

*I could not have achieved any significant standard in it without one to one support at the times I needed it, and they are the times that I experienced the most maths anxiety. The difference is, I did not give up*
James

Challenge and, whatever happened when I was in school around maths, that has created [the] anxiety I have around it. So, I suppose I haven’t been able to fully meet my potential in relation to maths. ... It’s probably not something that I would ever be able to know 100 per cent. It’s not fully my cup of tea.

Mark

If I could apply in real life it makes sense. If I can’t it’s just numbers and letters, and I suppose when I know now that I’m definitely going to need to use a lot of maths, it’s sort of a goal to work towards to.

Tina

It’s probably just a means to an end really. Like you know I have to do it to get this course, so I’ll do it like.

Eve

Frustration now. It was an easier subject for me years ago, I didn’t find it so much an issue. So, I never really thought about it. ... The five minutes homework or the 20 minutes homework, it was done quick, you understood it and you enjoyed it because you were waiting for the next challenge but yes, frustration is a big thing yes. ... Maths is just not my friend anymore.

Summary

These students presented a variety of personal characterisations for mathematics in their lives. Some show their appreciation of mathematics as universal, and part of everyday life, with a sense of clarity. Others expressed their feelings using metaphors and symbols to demonstrate the significance of mathematics in their lives. The characterisation of mathematics as a journey was popular with many students, and allowed them to reflect on how that has evolved over time.

6.11 Conclusion

This chapter has presented the analysis of the qualitative – life story interview – data in respect of twenty mature students who opted in to be interviewed. The students shared their mathematics life stories, using recollections on their feelings about mathematics – including their engagement with mathematics through the different stages of their schooling and education, the significant people in their mathematics lives, their strategies for engaging with mathematics, their views on mathematics in their future careers – and which culminated in the student giving a theme to their relationship with mathematics.
Affording the interviewee the opportunity to look back with reference to the path taken, as well as significant events and relationships along that journey, the mathematics life story aims to shed light upon the life course that the student associates with their engagement with mathematics and helps to elucidate how they feel about the subject in the context of their mathematics life story.
Chapter 7 Findings
7.0 Introduction

This chapter presents the results of the research using the analysis of the data – thereby drawing from chapters 4, 5 and 6 – and addressing the two research questions (RQs). RQ1 is addressed using the quantitative analysis of the questionnaire data presented in chapter 4. RQ2 is addressed by bringing together the quantitative (survey) analysis, particularly the MAS-UK scores for the twenty students who opted in to participate in phase 2 (chapter 5), and the interview data analysis for these same twenty students as structured by the adapted life story framework (chapter 6).

7.1 Addressing Research Question 1

RQ1: To what extent does mathematics anxiety exist among mature students studying service mathematics in Ireland?

The first research question examines the extent of mathematics anxiety among mature students in Ireland who study service mathematics as part of their undergraduate degree programme. The direct answer to RQ1 is that mathematics anxiety does exist among this sample of 107 mature students studying service mathematics in Ireland. The following sections present the findings of the survey (the analysis of which has been presented in Chapter 4) and elaborate on the extent of the anxiety towards mathematics that exists.

Mature Students’ Rating of Anxiety towards Mathematics using the MAS-UK

Respondents’ MAS-UK scores spanned a wide range of levels of mathematics anxiety, from the lowest possible level to having a great deal of anxiety. Although there were many occurrences of scores at the lower end of the scale, no scores in this sample reflected the upper extremity of this scale, or respondents that would be ‘very much anxious’ (Hunt et al., 2011). While the overall MAS-UK score gives one number to represent each mature student’s level of anxiety, it is necessary to explore the individual scores in more detail; the following sections explore the MAS-UK scores in respect of the other variables from the questionnaire. This is followed by an examination of the three factors that comprise the MAS-UK – mathematics evaluation anxiety, everyday/social mathematics anxiety, and mathematics observation anxiety – and an exploration of how the scores for the individual factors relate to the MAS-UK scores and to other variables.
**MAS-UK and Gender, Age and First Language**

Within this cohort of mature students, there was no significant difference between mathematics anxiety levels among male and female students. Most of the cohort had English as their first language, and these students indicated higher levels of mathematics anxiety than those who did not have English as a first language. This points to the fact that these students are from overseas and have experienced a different education system to that in Ireland, and also suggests that having to study through the medium of English does not necessarily exacerbate the anxiety level presented.

**MAS-UK and Years out of School, HEI, and Programme, Discipline and Level of Study**

Mature students who were out of school for many years showed lower levels of anxiety in respect of writing answers on the board in front of a class; while situations involving algebra – reading the word algebra and watching someone working out an algebra problem – did seem to cause anxiety among these respondents the longer they were out of school.

There was no significant difference between the scores of mature students who attended IoTs or Universities. However, the mature students’ disciplines of study showed higher levels of mathematics anxiety among Humanities and Arts students, as well as Health and Welfare, and Education students. In contrast, there were lower levels of anxiety among students studying in the remaining disciplines (Services; Social Sciences, Business and Law; Engineering, Manufacturing and Construction; Science, Mathematics and Computing). Further, in terms of the level of programme undertaken, mature students doing a level 8 programme had lower levels of mathematics anxiety, compared with level 7 and level 6 students who had the highest level; however, the sample sizes in each level group differed considerably.

**MAS-UK and Awareness of Mathematics in Programme of Study, Mathematics Preparation for HE, Completion of another Programme**

Higher levels of mathematics anxiety existed among mature students who had not known about the mathematics in their programmes of study before entering HE. Further investigation of these ‘not-aware’ students found that most of them had English as a first language, so language difficulty was not a factor. This suggests a lack of awareness about
the programme content, and poses the question if the student had known about the mathematics content, would they have proceeded with their programme of study?

Over half of the mature students updated their mathematics knowledge – either by attending a preparatory programme in mathematics, and/or engaging in private study of mathematics – before starting at the HEI, and these demonstrated slightly lower levels of mathematics anxiety compared with those who did not, suggesting that preparation in advance – regardless which method of preparation taken – helped to lessen their anxiety towards mathematics. Almost two-thirds of mature students had completed another programme of study since leaving school, and these students demonstrated slightly higher levels of mathematics anxiety compared with those who did not complete another programme. Further investigation into these results indicated that those who had not completed a programme of study but had prepared for mathematics before starting their current programme of study had lower levels of mathematics anxiety. It is possible that not having done another programme meant that these students took a fresh approach to starting higher education and took it upon themselves to be prepared for mathematics.

Almost all of the mature students who had completed another programme of study since leaving school commented on their feelings about the mathematics that they encountered in that programme (Table 4.12). They expressed how they felt using a variety of positive, negative and contrasting responses:

- Positive responses were characterised in terms of four themes: relevance of mathematics; enjoyment of mathematics; comfort with mathematics; competence in mathematics;

- Negative responses comprised feelings about how they perceived the mathematics: stressful, time consuming, difficult, tough, hard; and feelings they themselves had when doing – or anticipating doing – mathematics: not great, anxious, terrified, insecure, apprehensive, out of depth, not up to standard;

- Contrasting responses illustrated a contrast or transition from one feeling about mathematics to a different way of feeling; for example, where mathematics was difficult or fast paced at first, but with time, effort, and hard work things improved; daunting to determined; nervousness to confidence; seeing the relevance and importance of mathematics over time.

The MAS-UK scores of students who provided positive comments had a low range, while the scores for those providing negative comments had a higher range. Scores for the contrasting responses lay in between the positive and negative ranges. This analysis
showed a connection between the level of anxiety towards mathematics and the words students used to express their feelings towards mathematics.

**Rating of Ability in Mathematics**

Students who rated their ability highly in mathematics had lower MAS-UK scores, and vice versa. This was the case when students rated themselves on their ability in mathematics in primary and secondary school, since leaving school, and ‘today’ (at the time of completion of the questionnaire).

**Awareness of Mathematics Support Service**

Students who were aware of the mathematics support service offered by the HEI were considerably less mathematics anxious than those who were not aware. Further investigation into this finding reveals that the MAS-UK scores are lower among university mature students who were aware than IoT mature students who were aware. Of those students who were not aware of the mathematics support service, mature students from IoT2 had the highest MAS-UK score, and a majority of these students did not know about the mathematics support service at that HEI, suggesting that IoT2 mature students are not as well informed about the mathematics support as mature students in the other HEIs.

Mature students with higher levels of mathematics anxiety expressed their intention to use the mathematics support service; this is particularly the case for mature students from IoT1 and IoT2. In contrast, university respondents had lower MAS-UK scores despite intending to use the mathematics support service. Those who did not intend using the service were considerably fewer in number and had relatively lower MAS-UK scores, particularly in IoT1 and IoT2, which suggests a higher confidence in their own ability in mathematics. In contrast, just over one quarter of respondents did not know if they intended using the service and had relatively low MAS-UK scores, apart from IoT2 respondents, who showed a moderate anxiety level. Further investigation of these ‘don’t know’ findings cross referenced with the respondents’ awareness of the service showed less mathematics anxiety among the respondents who were aware of the mathematics support service. It is likely that at the time of completing the questionnaire, they were aware of the mathematics demands and requirements of their programme and possibly felt that they would not need to use the mathematics support service.
Mathematics in Future Career

More than three quarters of the respondents asserted that mathematics would feature in their future careers, and their MAS-UK scores were relatively low. The ‘don’t know’ respondents also had relatively low levels of mathematics anxiety. In contrast, the mathematics anxiety levels among the ‘no’ respondents were higher, suggesting a preference to avoid or not wanting to engage with mathematics in the future.

7.1.1 Mathematics Anxiety by Factor

Each of the three factors of the MAS-UK have been examined by taking the individual scores of the respondents for each factor in respect of the levels of anxiety presented in each and comparing those scores with other variables of significance. These findings are presented below.

Factor 1 Mathematics Evaluation Anxiety

Mathematics evaluation anxiety pertains to contexts whereby the person is actively involved in completing a mathematics task with the prospect of being evaluated by someone else (Hunt et al., 2011). It is prevalent among this cohort, albeit at varying levels from the minimum to the maximum score. Situations that result in higher levels of anxiety include situations of testing or examinations and doing calculations in the presence of the teacher/lecturer and classmates. In contrast, situations involving working out a multiplication or division problem with or without someone present seem to cause little or no anxiety for the majority of these mature students. The low scores also suggest a confidence in the students’ own ability in respect of doing these calculations; this is corroborated by the finding that low scores for factor 1 related to high perceived levels of ability in mathematics (at the time of completion of the questionnaire), and vice versa. Further, respondents with high factor 1 scores also have high MAS-UK scores, and vice versa.

Factor 2 Everyday/Social Mathematics Anxiety

Everyday/social mathematics anxiety looks at contexts whereby the person is actively involved in performing a calculation or activity involving using numbers in an everyday situation or social context (Hunt et al., 2011). Instances of everyday/social mathematics anxiety are relatively low among this cohort. These statements correspond to situations that people would be familiar with often on a daily basis, and consequently may result in
little or no anxiety; for example, the statement with the lowest anxiety levels was ‘Adding up a pile of change’, where more than three quarters of respondents indicated they were ‘not at all anxious.’ In addition, no respondent scored ‘very much’ anxious to the statement ‘Calculating how many days until a person’s birthday’. Only one statement showed slightly higher levels of everyday/social mathematics anxiety among this cohort – statement 8: – ‘Being given a telephone number and having to remember it’; this is a task that is becoming less essential in the world of mobile telephony, whereby telephone numbers can be stored digitally without the need to remember them. Thus, it is likely that this is a task that a person does not have to do often, and the prospect of not being able to remember the number – or forgetting the number – may have social implications and may lead to anxiety. In addition, examination of the factor 2 scores and the MAS-UK scores show respondents with higher scores in factor 2 also have higher scores in the MAS-UK, and vice versa; while higher perceived ratings of ability in mathematics – at the time of completion of the questionnaire – relate to lower factor 2 scores, and vice versa.

**Factor 3 Mathematics Observation Anxiety**

Mathematics observation anxiety relates to situations whereby the person takes a passive role, being in an environment with mathematical content or observing aspects of mathematics being performed by someone else (Hunt *et al.*, 2011). Instances of mathematics observation anxiety are relatively low among this cohort, with a majority of situations showing little or no anxiety among this cohort. There were more varied scores for two statements: statement 15 - ‘Reading a maths textbook’, and statement 20 - ‘Watching a teacher/lecturer write equations on the board’, with slightly higher levels of anxiety. It is likely that the respondents’ perception of reading a mathematics textbook is that it would be complicated and pose a challenge for them; similarly, watching a teacher or lecturer writing equations on the board – while a passive activity – may suggest that understanding the equations – perhaps out of context – would pose a challenge, thereby leading to raised levels of anxiety for some students. The findings did show that the longer these mature students were out of education, the more anxious they were in respect of engaging with algebra, i.e. reading the word algebra, and watching someone working out an algebra problem. In addition, examination of the factor 3 scores and the MAS-UK scores show respondents with high scores in factor 3 also have high scores in the MAS-UK, and vice versa; and higher perceived ratings of ability in mathematics – at the time of completion of the questionnaire – relate to lower factor 3 scores, and vice versa.
7.1.2 Summary

The intention behind section 7.1 was to address the first research question (RQ1) – *To what extent does mathematics anxiety exist among mature students studying service mathematics in Ireland?* Mathematics anxiety does exist among this cohort of 107 mature students, and since the profile of these students corresponds largely with the profile of mature students as presented in the literature, it is likely that the issues and challenges the respondents encounter as they study service mathematics are indicative of what other mature students in Ireland experience.

The extent of mathematics anxiety among these students varies and takes on different forms. Considerations of mature students’ age, gender, first language, HEI sector (Uni or IoT) attended, and discipline of study presented no evidence that contradicted the existing literature. Almost all of these mature students were aware that their programme of study had a mathematics component. There was benefit for those mature students who had prepared for mathematics before starting their programme of study, and attendance at HEI preparatory courses and self-study in mathematics were popular approaches among these students. A majority of these mature students were aware of the mathematics support service at their HEIs, with the largest proportion attending IoT1; in contrast mature students from IoT2 were largely not aware of the mathematics support service, which raises concern for the possible lack of publicity of the service for students at that HEI.

Positive experiences with mathematics are characterised by these mature students in terms of mathematics being relevant and enjoyable, and the students feeling comfortable with and competent in mathematics. Negative experiences with mathematics included the students’ perception of mathematics as stressful, time-consuming, and difficult, and their own negative feelings about doing mathematics, including apprehensive, insecure, anxious, terrified, out-of-depth, and not up to standard. Some students mentioned the importance of time, effort, and hard work in helping them see mathematics which they had previously perceived as difficult and challenging as now being something achievable, relevant, and important. Despite these differing views, the majority of this cohort sees mathematics as being part of their future careers, while the others would prefer to avoid it.

While the questionnaire results provided an insight into these students’ backgrounds, and their return to education, much detail has been provided through the analysis of the MAS-
UK itself and its three factors; the analysis of the individual factors has given an insight into the types of scenarios that lead to higher levels of anxiety among these mature students. Analysis of the mathematics evaluation anxiety factor showed higher scores than for the other two factors. In particular, situations of testing and evaluation are pivotal in resulting in higher anxiety levels, as well as being asked questions by the teacher or lecturer, and being asked by the teacher or lecturer to do questions in front of others. The role of the teacher is significant here, as is the mathematics topic being addressed.

Everyday/social mathematics anxiety had the lowest range of scores, i.e. lower anxiety towards dealing with mathematics in such situations, reflecting the familiarity of many of these situations within the cohort. The significance of the social implications of some everyday situations has an impact of the level of anxiety experienced.

The third factor – mathematics observation anxiety – had many low anxiety scores; however, situations involving reading a mathematics textbook, and watching the teacher/lecturer writing equations on the board resulted in raised anxiety levels within this cohort. This points to the perceived complexity of mathematics textbooks, and also the complexity of equations, especially if presented out of context by the teacher or lecturer.
7.2 Addressing Research Question 2

RQ2: What specific incidents in a mature student’s life story results in the level of mathematics anxiety that the student experiences?

In order to address the second research question, it is necessary to combine the scores elicited through the MAS-UK with the analysis of the interview data, thereby mixing the quantitative and qualitative datasets with the intention that the qualitative data will provide a better understanding of the quantitative (Creswell & Plano Clark, 2011). In this context, and in order to look more closely at the specific incidents that may lead to the mature student’s level of mathematics anxiety, the results of the MAS-UK of the twenty mature students are sub-divided into the three factors – mathematics evaluation anxiety, everyday/social mathematics anxiety, and mathematics observation anxiety – and the scores for each factor are presented using a trend graph with exaggerated points representing the students’ scores on that factor ranging from low scores (lower levels of mathematics anxiety for the factor) to higher scores (higher levels of mathematics anxiety for the factor).

As only one variable – the set of scores for the 20 respondents – is present for each factor, the membership of each cluster was determined visually (Kaufmann & Rousseeuw, 2005; Tryfos, 1997) by the researcher. The positioning of the scores is used to divide the students into clusters of people who scored similarly, resulting in clusters of low, mid-range and high scores for each of the three MAS-UK factors. The interview data of the participants of each cluster is used to elucidate the scores obtained on the three MAS-UK factors resulting in that level of anxiety experienced and exploring the incidents according to Cemen’s (1987) model of environmental, dispositional and situational antecedents. In this way, the presentation of findings is utilising a mixed method approach to the integration and interpretation of the two datasets.

7.2.1 Factor 1 Scores: Mathematics Evaluation Anxiety
As discussed in section 2.6.1, Factor 1 of the MAS-UK examines the levels of anxiety perceived by the student in situations of mathematics evaluation and comprises nine statements (Table 7.1), allowing a range of scores from a minimum of 9 to a maximum of 45.
Table 7.1 Mathematics Evaluation Anxiety Factor Statements

<table>
<thead>
<tr>
<th>Mathematics Evaluation Anxiety</th>
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<tbody>
<tr>
<td>1. Having someone watch you multiply 12x23 on paper</td>
</tr>
<tr>
<td>3. Being asked to write an answer on the board at the front of a maths class</td>
</tr>
<tr>
<td>6. Taking a maths exam</td>
</tr>
<tr>
<td>7. Being asked to calculate €9.36 divided by 4 in front of several people</td>
</tr>
<tr>
<td>10. Calculating a series of multiplication problems on paper</td>
</tr>
<tr>
<td>18. Being given a surprise maths test in a class</td>
</tr>
<tr>
<td>19. Being asked to memorise a multiplication table</td>
</tr>
<tr>
<td>21. Being asked to calculate three fifths as a percentage</td>
</tr>
<tr>
<td>23. Being asked a maths question by a teacher/lecturer in front of a class</td>
</tr>
</tbody>
</table>

Figure 7.1 shows the Factor 1 scores for all 20 participants, ranging from 12 to 42:

Figure 7.1 Clusters of Factor 1 Scores

- Cluster 1 – low range mathematics evaluation anxiety with scores from 12 to 15 (Evan, Neo, Ken and Mike)
- Cluster 2 – lower mid-range mathematics evaluation anxiety with scores from 20 to 25 (Con, Alec, Jon, Lisa, Shay, Mark and Lynn)
- Cluster 3 – upper mid-range mathematics evaluation anxiety with scores from 29 to 33 (Dan, Eve, Anna, Sam and Kate)
- Cluster 4 – high range mathematics evaluation anxiety with scores from 39 to 42 (Tina, James, Gayle and Pat).
Each cluster of scores is further explored below in respect of the qualitative data and findings relating to situations of mathematics evaluation. Hunt and colleagues (2011) described such situations as involving mathematics calculations, testing or examination, being evaluated by someone else while doing mathematics, and being evaluated in mathematics in a public context. Thus, finding out what the students said in respect of situations of mathematics evaluation necessitates a review of the qualitative data analysis (Chapter 6). Table 7.2 shows the list of relevant words23 sourced from the analysis of the qualitative data.

Table 7.2 Words used to Review Situations of Mathematics Evaluation

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<tbody>
<tr>
<td>Algebra</td>
<td>Divi+</td>
<td>Learn off</td>
<td>Pressure</td>
<td>Support</td>
</tr>
<tr>
<td>Answer</td>
<td>Exam+</td>
<td>Lecture+</td>
<td>Problem</td>
<td>Teacher</td>
</tr>
<tr>
<td>Anxiety</td>
<td>Father</td>
<td>Memorise</td>
<td>Public</td>
<td>Test+</td>
</tr>
<tr>
<td>Assess+</td>
<td>Fraction</td>
<td>Mother</td>
<td>Question</td>
<td>Tutor+</td>
</tr>
<tr>
<td>Child+</td>
<td>Hand+</td>
<td>Multipl+</td>
<td>Sibling</td>
<td></td>
</tr>
<tr>
<td>Class</td>
<td>Kid</td>
<td>Parent</td>
<td>Stand</td>
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</tbody>
</table>

The review of the qualitative data using the above keywords and synonyms resulted in the following findings in respect of each cluster of mature students. The findings are presented by cluster, starting with a summary of the relevant quantitative data and findings from the nine items on the mathematics evaluation anxiety factor. Within each cluster the incidents are presented under the headings of environmental, dispositional, and situational in order to align with Cemen’s model.

7.2.1.1 Cluster 1 – Low Mathematics Evaluation Anxiety

This section looks at the findings for the cluster of four mature students – Evan, Neo, Ken, and Mike – who have low scores on the mathematics evaluation anxiety factor. The students are males, aged 44, 36, 46, and 33 respectively, with two from IoT1 (both Level 7) and two from Uni2 (both Level 8). Three are studying in the Engineering, Manufacturing and Construction discipline, and the other Science, Mathematics and Computing. All knew there would be mathematics module(s) in their programmes before starting at the HEI.

23 Words followed by a + sign indicates these are stem words, to which may be added additional letters in different contexts, for example, exam+ can be a stem for examination, examiner, examine, exams.
All did a preparatory course in mathematics\textsuperscript{24} and three did self-study in mathematics to improve their mathematics before starting their course. In the MAS-UK test, they scored 28, 29, 31 and 33 respectively. All scores from these four students in the mathematics evaluation anxiety factor were either 1s, 2s, or 3s (Figure 7.2) suggesting no indications of the students being much (score of 4) or very (score of 5) anxious in respect of these situations of evaluation.

![Figure 7.2 Low Mathematics Evaluation Anxiety Distribution of Scores](image)

Evan scored mostly 1s (6) and scored 2 three times. The highest combined scores were given to statement number 6 ‘Taking a maths exam’ (2, 3, 3, and 3) and statement number 18 ‘Being given a surprise maths test in a class’ (2, 2, 3, and 2). In contrast, the lowest combined score of 4 (rating of 1 from each student) went to three statements:

- 1. Having someone watch you multiply 12x23 on paper
- 10. Calculating a series of multiplication problems on paper
- 21. Being asked to calculate three fifths as a percentage

These were closely followed – with a combined score of 5 – by statements:

- 3. Being asked to write an answer on the board at the front of a maths class
- 7. Being asked to calculate €9.36 divided by 4 in front of several people

\textsuperscript{24} Ken did not answer this question on the questionnaire; however, he disclosed in the interview that he had done the summer course in mathematics at the HEI. It is possible that the wording of the question in the questionnaire may have been unclear, i.e. he may not have associated a preparatory course with the summer course he did and declined to answer.
It is evident from these scores that these students have low anxiety about performing calculations and about doing so in front of others. Situations of testing and examination seem to cause higher levels of anxiety.

The following section presents the significant incidents for those students with low mathematics evaluation anxiety; presentation of these findings adheres to Cemen’s three categories of antecedents: environmental, dispositional, and situational. Presentation of the findings for RQ2 resulted in using a modified version of Cemen’s model to suit the data (Appendix T). Environmental antecedents included subcategories of parental encouragement, past experiences, and falling behind and inability to catch up. Dispositional antecedents included extent of self-doubt, attitudes to mathematics, and prior avoidance. Situational antecedents included mathematics as a subject, classroom factors, the way mathematics is taught, and the test situation. These subheadings are presented insofar as they reflect the findings for each cluster of students.

**Significant Environmental Antecedents for Students with Low Mathematics Evaluation Anxiety**

*Parental Encouragement*

These students had contrasting experiences of the involvement of parents in their learning of mathematics. The extent of parental encouragement and support was dictated by the level of expertise in mathematics that the parents themselves had; and parental confidence in mathematics positively influences their child’s confidence.

*Past Experiences*

Positive experiences of learning mathematics at primary school included mathematics being fun, and having small class sizes, so that individual attention was possible. A ‘good grounding’ in mathematics laid the foundation for subsequent mathematics, enhancing student confidence. In contrast, memories of doing times tables were not so positive especially when standing in front of the class; feeling anxious and under pressure about doing mental arithmetic, feeling intimidated by times tables, and being punished in front of the class also played a role in these students’ engagement with mathematics.

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25 The dispositional antecedent topic *Sex role/social stereotype* did not arise in the data and has not been included for discussion.
At secondary school, experiences of teacher intimidation and punishment featured among these students; in addition, the teacher being inaccessible to one student was an issue that led to that student finding mathematics learning difficult and disengaging from mathematics. Scheduling of mathematics classes days apart did not help another struggling student, whose questions went unanswered, leading to frustration with mathematics. One student felt that there was a sense of who the bright kids were in the class and their learning was prioritised at the expense of those who were not as bright. Teacher behaviour such as name-calling, scaring the children, and publicising results impacted negatively on students’ self-esteem. The teaching methods were challenging for some students who could not grasp the mathematics concepts.

*Falling behind and Inability to catch up*

Due to the limited amount of time in class, and being unable to approach the teacher, questions were left unanswered and these accumulated, leading to confusion and eventual disengagement with mathematics.

**Significant Dispositional Antecedents for Students with Low Mathematics Evaluation Anxiety**

*Self-Doubt and Approach to Preparation*

The wording of examination questions can lead to doubt in the student’s ability to proceed with answering. The students have confidence and determination about their preparation for mathematics. Each of these students is well prepared for examinations. Attendance at all classes and asking questions of lecturers (usually one-to-one) and tutors is significant to facilitate understanding, as is attendance at the mathematics support centre, and plenty of effort and practice of mathematics problems, resorting to starting with the basics if necessary. Attendance at all classes – sometimes attending more than one tutorial per week – and keeping on top of the workload from lectures has helped one student become very confident in mathematics and be successful in mathematics.

*Impact of Failure*

Each of these students experienced failure in mathematics and showed determination to move on from that and succeed in mathematics. Failure was the impetus to do better the next time, and therefore acted as a motivator. Having the opportunity to do additional mathematics after finishing school was of benefit when the student wanted to enter HE.
**Attitudes to Mathematics**

Understanding the mathematics is central to progressing and to developing their confidence in the subject. They are aware of the importance of mathematics in their lives and for their future careers.

**Significant Situational Antecedents for Students with Low Mathematics Evaluation Anxiety**

**Classroom Factors**

These students are proactive about asking for help. However, there is feeling that the lecture itself – due to its size and/or the public setting is not conducive to asking questions.

**The Way Mathematics is taught**

The lecturers are seen as approachable, and capable, having a good rapport with students; however, there is a perceived assumption that all students have done the LC, and that may not be the case, which can be frustrating for mature students. The mathematics support centre provides a beneficial service to these students, in that there is one-to-one attention, the pace is slower than in the lecture, and the staff have time to explain. These students are proactive about availing of this service frequently; however, they are aware that not many students in their cohort use this service.

**Test Situation**

While dealing with exams can be challenging, having a strategy to approach the examinations is useful. Having a continuous assessment component in a module is beneficial, as students can see progress during the term and know how they fare in mathematics before the terminal examination.

**Additional comments**

These students have declared minimal levels of mathematics evaluation anxiety; having had limited parental encouragement and assistance with their mathematics, they have overcome the challenges they experienced with mathematics at primary and secondary school. Their experience of mathematics in the workplace has helped them gain an appreciation for the subject and a confidence to engage with it constructively in HE. When they need help with their service mathematics coursework they proactively seek it.
This section looks at the findings for the cluster of seven mature students – Con, Alec, Jon, Lisa, Shay, Mark, and Lynn – who have scores from 20 to 22 out of 45 on the mathematics evaluation anxiety factor. These students comprise two females and five males, with ages ranging from 24 to 49. Three are from the IoT sector, and four from the Uni sector. Three study in the Engineering, Manufacturing and Construction discipline, and the others represent one each in Science, Mathematics and Computing, Humanities and Arts, Education and Social Sciences. Three students – Jon, Shay and Lynn (all Uni sector) – did not know there was a mathematics component in their programmes of study, and therefore did not update their knowledge of mathematics beforehand; and only two of the students who did know about the mathematics module in their programmes – Lisa and Mark – updated their mathematics knowledge by doing a preparatory course at the HEI (Lisa) and self-study of mathematics (Mark) before starting the programme. In the MAS-UK test their scores ranged from 37 (Con) to 59 (Jon). Figure 7.3 shows the allocation of scores for each student in the lower mid-range mathematics evaluation anxiety factor.

![Figure 7.3 Lower Mid-Range Mathematics Evaluation Anxiety Distribution of Scores](image)

Most students’ scores are clustered around scores of 2 and 3. A notable exception is Jon with five 1s and three 5s. Closer examination of Jon’s scores indicates high anxiety (5) in
situations of examination and testing (statements 6, 18 and 23), a score of 3 for statement 3, and seemingly no issues (scores of 1) for performing multiplication and division calculations. Nobody scored 1 for statements 3, 6, 18 and 23, indicating the existence of anxiety – at varying levels – when faced with situations of examination or testing, as well as being asked to do a mathematics problem in front of the class.

**Significant Environmental Antecedents for Students with Lower Mid-Range Mathematics Evaluation Anxiety**

*Parental Encouragement*

Among these students, the role of the mother was conveyed as presenting a positive impression of mathematics. However, parents also had fixed mindsets about mathematics, and others inflicted punishment for failure.

*Past Experiences - Primary school*

Primary school mathematics learning was experienced as fun, with an emphasis on learning times tables but no negative recollections of doing so.

*Past Experiences - Secondary School*

Many of these students had negative experiences at secondary school; not understanding the context for the mathematics taught at junior cycle, the inability of the teacher to explain and lack of support from the teacher. The focus on passing the examination rather than understanding what the mathematics were about contributed to a lack of interest in the subject. The impact of a change of teacher varied from contributing to anxiety due to inadequate teaching methods and seeming indifference to what the children were learning, to experiencing different ways of doing problems which was of benefit. For the two older students, physical abuse was inflicted by the teacher, with negative and even traumatic impact on the students in respect of their subsequent engagement with mathematics.

*Falling behind and Inability to catch up*

Absence from school due to illness resulted in one student being unable to catch up with missed content and without support from the teacher, leading to disengagement with mathematics. For some students coping with the challenges of mathematics meant dropping to a lower level in order to avail of a less-demanding syllabus.
Significant Dispositional Antecedents for Students with Lower Mid-Range Mathematics Evaluation Anxiety

Self-Doubt and Approach to Preparation

The impact of being told you were ‘bad at mathematics’ has been extensive for one student. Effort is important to succeed with mathematics, as is the help of someone else. It is important to grasp a concept and repetition soon after class is important. Knowing topics before they appear in the lecture can be helpful. Being able to visualise a problem is significant in how one approaches it, and this is often a challenge with more abstract concepts like algebra. Knowing the relevance of mathematics helps to retain the concepts.

Attitude to Mathematics

There is an awareness among both Irish and foreign students that mathematics is an important subject to enter HE. However, there is a sense that some mathematics module titles are disguised so that potential students will not be deterred from applying.

Prior Avoidance

A history of avoidance of mathematics can prompt an individual to opt for a programme that seems unrelated to mathematics. However, the study of many disciplines includes exposure to mathematics, even though that may not be evident from the programme title.

Significant Situational Antecedents for Students with Lower Mid-Range Mathematics Evaluation Anxiety

Mathematics as a Subject

There is an emphasis on getting the answer, and this is in contrast with other subjects, where you might have a chance to argue a point. There is a reliance on online resources such as YouTube and Khan Academy for help with understanding mathematics.

Classroom Factors

Tutorials are conducive to learning due to their small size, the attention given to the students by the lecturers/tutors, and the ability to ask questions.

The Way Mathematics is taught

Those students who did avail of the HEI preparatory mathematics course found it beneficial and impacted their subsequent approach to mathematics at HE positively. If
the lecturer can present the relevance of mathematics it helps these students to understand and apply it better; while a lack of enthusiasm on the part of the lecturer can be demotivating. While mathematics support is available at each HEI, not all students were aware of this – particularly IoT2 students – or availed of the service. The MSC staff show empathy and are very obliging to the struggling student. Mathematics support is only available to year 1 students at IoT1, while some mature students enter programmes in year two, and cannot avail of this service. In addition, some students have peer support.

Test Situation

There are different approaches to preparing for the examinations, including learning off material, or being selective in learning what will allow you to pass the module.

Additional Comments

The exactness of certain mathematics work can cause anxiety, because it suggests there is only one right answer, and that seems to be all that matters. When the student does not get that answer and does not know how they did not get it, that can be off-putting. And multiple incidents like this can be detrimental in the bigger scheme of mathematics learning.

Not all students were aware of the mathematics support centre at their HEI, and for those who were aware, not all engaged with the service. Some students relied on attendance at tutorials as well as support from peers. Lecturers mostly present mathematics as relevant, but on occasion can teach to the test.

For some mature students, there is a preference to learn off material, without regard to the understanding of concepts; the intention for some is to pass the examination.

7.2.1.3 Cluster 3 Upper Mid-Range Levels of Mathematics Evaluation Anxiety

This section looks at the findings for the cluster of five mature students – Dan, Eve, Anna, Sam and Kate – who have scores from 29 to 33 out of 45 on the mathematics evaluation anxiety factor. They comprise two males and three females, with ages ranging from 27 to 39. Two are from the IoT sector, and three from the Uni sector (all Uni2). Two study in the Engineering, Manufacturing and Construction discipline, and the others represent one each in Science, Mathematics and Computing, Education and Social Sciences. All five students knew there was a mathematics component in their programmes of study, but only two – Dan and Kate – updated their mathematics knowledge beforehand by attending a
preparatory course at the HEI; in addition, Dan engaged in self-study of mathematics. In the MAS-UK test their scores ranged from 56 (Dan) to 67 (Sam). Figure 7.4 shows the allocation of scores for each student in the mathematics evaluation anxiety factor.

![Figure 7.4 Upper Mid-Range Mathematics Evaluation Anxiety Distribution of Scores](image)

Many scores are clustered around scores of 3, 4 and 5, with notably fewer at the lower end of the scale (scores of 1 and 2). Statements pertaining to mathematics examinations scored highest among this cluster; all students gave a score of 5 to statement 6 ‘Taking a maths exam’. Statement 23 ‘Being asked a maths question by a teacher/lecturer in front of a class’ scored three 5s and two 4s, and statement 18 ‘Being given a surprise maths test in a class’ scored three 5s, one 4 and one 3. Kate had the highest score (33) and had scores of 2 or higher, demonstrating anxiety in varying forms for different statements, including scores of 5 for each of statements 6, 18 and 23.

**Significant Environmental Antecedents for Students with Upper Mid-Range Mathematics Evaluation Anxiety**

**Parental Encouragement**

Among these students, the role of the mother was conveyed as a supportive one in respect of primary mathematics. However, some parents demanded high academic achievement.
Past Experiences – Primary school

Primary school mathematics learning was experienced with a sense of enthusiasm, and times tables were often learned by heart, but this did not pose problems.

Past Experiences – Secondary School

Positive recollections of these student are in respect of the teacher being supportive, and inspirational, and being able to explain mathematics in a way that made sense. Many of these students had negative experiences at secondary school; not understanding the context for senior cycle mathematics taught, the teacher’s inability to explain and lack of support, particularly in respect of advice on the level of mathematics taken. The abstractness of some mathematics concepts such as algebra contributed to the difficulties with mathematics. The impact of a change of teacher was detrimental because it altered the dynamic in the class.

Falling behind and Inability to catch up

Being unable to question the advice of teachers in respect of the level of mathematics pursued meant you might have limited your subsequent choices for mathematics and career options.

Significant Dispositional Antecedents for Students with Upper Mid-Range Mathematics Evaluation Anxiety

Approach to Preparation

Effort is important and necessary to do well in mathematics, as well as trying it out in different ways is helpful. Going back to the basics is also necessary at times. However, some may resort to cramming, or trying to memorise/learn off mathematics before the examination. Being able to see the relevance of mathematics helps to understand concepts, as does trying to interpret it into English.

Attitude to Mathematics

Having used mathematics in a work context helps to see the relevance of the mathematics, and how it aligns with other subjects. There is a need to get help to succeed with the mathematics in the programme, but once that is finished, there is a preference to avoid mathematics.
Significant Situational Antecedents for Students with Upper Mid-Range Mathematics Evaluation Anxiety

Mathematics as a Subject

YouTube and Khan Academy are popular online resources for additional help with understanding mathematics, as they allow you to go through it at your own pace and repeatedly. The amount of mathematics in a programme can come as a surprise to some students and can take up much study time at the expense of studying other subjects. There is awareness that there is likely a difference in knowledge between traditional and mature students, due to the time the latter have been out of formal education.

Classroom Factors

Some lecturers give notes to supplement the mathematics lectures and this is helpful to facilitate understanding of topics. However, not all lecturers are available to students at the end of lectures and this is regretted by some students who would like to ask questions after class, as it is not feasible to raise your hand in a large lecture hall. The pace and size of some lectures, as well as the volume of material to get through are also challenges identified by these students. However, due to timetabling constraints, tutorials are not always possible to attend. In addition, lecturers/tutors may only have a small amount of time to spend with each student. There is time pressure on the student here, and that can add to the anxiety, because the problem will not get resolved if there is a time limit. In addition, there is a perception that there is miscommunication between what goes on in the lecture and the tutorial.

The Way Mathematics is taught

The MSC staff are very supportive of the struggling student, explaining the mathematics in a simplified way. However, other students do not engage for fear of looking silly or not being able to explain themselves.

Test Situation

Going blank in an examination context can be debilitating for a student leading to anxiety.

Additional Comments

Among these students there were varying levels of parental involvement in mathematics learning, with more positive experiences leading to positive attitudes towards
mathematics. Supportive teachers were also significant in facilitating a positive impression of the subject. However, the converse was also experienced, whereby negative teacher attitudes impacted upon the students’ engagement with mathematics adversely. A change of teacher led to different impressions of the subject and the teaching methods among the students. Absence from school due to illness meant difficulty in catching up, if at all, with no support at school in this regard. The need to pass the examination frequently led to strategic learning in order to get by, rather than fully understanding the concepts. Understanding the concept may necessitate going back to basics and trying out different approaches to get the answer, with a desire to get the right answer.

There is a sense of the challenges facing mature students in higher education; particularly in respect of the time demands of learning and understanding mathematics, and the need to adjust to the demands of the HE learning environment. There is also a sense that the students would like to engage with the lecturers and ask them questions, but that is not the experience of many of these students. Tutorials and the MSC are useful resources to these students, but timetabling constraints may mean they cannot avail of either.

7.2.1.4 Cluster 4 High Range Mathematics Evaluation Anxiety

This section looks at the findings for the cluster of four mature students – Tina, James, Gayle, and Pat – who have scores ranging from 39 to 42 on the mathematics evaluation anxiety factor. This cluster comprises two males, and two females; they are aged 31, 36, 38 and 34 respectively. Three students are in the IoT sector (one in IoT1 (Level 7), two in IoT2 (both Level 8)) and one in Uni1 (Level 8). Two are studying in the Humanities and Arts discipline, and the other two Science, Mathematics and Computing. All except Tina knew about the mathematics module(s) in their programmes before starting at the HEI; however, none of them updated their mathematics knowledge before starting their programmes. In the MAS-UK test, they scored 66, 83, 86, and 94 respectively. Figure 7.5 shows the allocation of scores for each student in the mathematics evaluation anxiety factor.
James had the most scores (7) with a rating of 5, followed by Tina and Pat with 6 each, and Gayle had 5. Pat’s responses are either 4s or 5s – much (score of 4) or very (score of 5) anxious – in respect of these situations of evaluation. The highest possible combined scores of 20 (each student rated 5) were given to statements:

- 3. Being asked to write an answer on the board at the front of a maths class,
- 18. Being given a surprise maths test in a class, and
- 23. Being asked a maths question by a teacher/lecturer in front of a class.

Close behind these with combined scores of 19 were statements:

- 6. Taking a maths exam and
- 7. Being asked to calculate €9.36 divided by 4 in front of several people.

Clearly, situations of examination and being put on the spot in front of a class rate as highly anxious situations for these students. Further, there is an obvious contrast between Figure 7.2 and Figure 7.5 with the skew of the former tending towards the low scores, while the skew for the latter tending towards the higher scores.

**Significant Environmental Antecedents for Students with High Mathematics Evaluation Anxiety**

**Parental Encouragement**

There is a lack or absence of parental encouragement among these students and where parents were involved it was limited to helping with primary mathematics. There was an
impression that parents’ focus was on getting the right answer. A competitive element between father and daughter existed, in that the father’s attempts to assert his competence in mathematics led to his daughter’s persistence at doing it by herself.

Past Experiences – Primary School

Standing up in class to answer questions caused anxiety among these students; in addition, awareness that you were standing beside someone good caused anxiety as well as getting the answer wrong and having to sit down. This was very much a public display of one’s lack of knowledge. Being singled out to answer a question led to panic due to not understanding and not knowing the answer. Each student referred to getting the answer, or getting it right, which they were often not able to do. Other problematic topics included multiplication, division and fractions. There was a sense that these students did not enjoy mathematics at primary school.

Past Experiences – Secondary School

Algebra was deemed a problematic topic; mysterious, abstract. There was a sense of teacher indifference to misbehaviour in class, or to whether the student understood or not. There is blame towards the teacher for allowing non-attendance at many mathematics classes which was detrimental to interest and engagement with the subject. There was a lack of support from the teacher causing anxiety at a ‘crucial time.’ Refraining from asking questions in class stemmed from not wanting to be judged by one’s peers. The emphasis on getting the right answer features prominently among these students; this was also coupled with doing problems within a given time frame. In an examination context, not being able to answer questions resulted in anxiety and subsequent failure of a state examination. Trying to do problems in different ways can result in different answers, adding to the confusion. While the belief that every mathematics problem must have an answer can motivate a student to find and arrive at an answer. Having a private tutor in mathematics helped for leaving certificate preparations.

Falling behind and Inability to catch up

Not having a chance to answer times tables questions or work it out for yourself meant there was a tendency to ‘continually fall behind’ and not improve. Knowing you were part of the lower class for mathematics impacted on self-confidence with the subject, and there was a sense that more attention was given to higher level students, and the
perception that better teachers are kept for the higher level classes. Being aware of the mathematics topics increasing in difficulty caused confusion and anxiety and led to students getting left behind.

**Significant Dispositional Antecedents for Students with High Mathematics Evaluation Anxiety**

*Extent of Self-Doubt*

Failure of a state examination (JC) can impact a student’s subsequent attitude and approach to mathematics. Examination papers can be perceived as having trick questions intending to catch out the student. The focus for these students is passing their mathematics modules, and they rely on knowing how much they have achieved in continuous assessment before the end of term, so they can target their preparation with a view to achieving the desired 40%.

*Approach to Preparation*

One student’s perception that he was unable to learn mathematics at school has had an extensive impact on his engagement with mathematics in HE. Another feels he has not learned a lot about mathematics but has learned to cope with a difficult subject. While a third learns off her mathematics without giving attention to understanding the content.

*Impact of Failure*

Fear of failure drives these students to cope with what they see as a challenging and difficult subject. Their aim is to pass mathematics, even if they do not understand it.

*Attitude to Mathematics*

Students are aware of the importance of mathematics as a gatekeeper subject, i.e. to enter HE and to move on with life. These students compare themselves with traditional students in their classes and believe there is a gap in knowledge between traditional and mature students. Seeing the relevance of mathematics is important in helping them to understand the subject. However, where that understanding is lacking, it can lead to discomfort, being lost with mathematics and feelings of panic in class.
Prior Avoidance

The impact of prior avoidance of mathematics – whether not attending class, or not pursuing a course of study because of mathematics components – can be far-reaching, resulting in students being strategic in their attempts to succeed with mathematics, as well as deferring a programme of study. There is a preference not to have to engage with mathematics at all.

Significant Situational Antecedents for Students with High Mathematics Evaluation Anxiety

Mathematics as a Subject

There is difficulty practising questions by oneself, as it is difficult to know if the question is right. There is a need for reassurance from someone else in this regard. While visualisation can help some students understand mathematics, it is difficult with abstract concepts. There is a sense that these students were never shown how to use a calculator properly, and they seem reluctant to use it in case of making a mistake.

Classroom Factors

There is a reluctance to ask questions in class for fear of disapproval among classmates. It would be desirable to ask the lecturer questions after class, but they either do not remain or the tend to give the answer when a more detailed explanation is what is required. Despite having email contact details for lecturers some students prefer the personal contact in respect of knowing they are doing mathematics the right way. Reassurance is significant here. Not having sufficient time to do mathematics problems can be a challenge.

The Way Mathematics is taught

Where a module might have more than one lecturer or tutor the presentation of topics can cause confusion especially for the struggling student if each person teaches it a different way. If the pace of the class is too fast, and covering a lot of material, it can be challenging to stay on track. In addition, if it is not clear where what is written on the board came from, that can cause a student to be lost. Further, if a lecture is not conducive to letting students ask questions – either during or after class – students will not be able to enhance their understanding. Support is important for these students, whether in the form of a
private tutor, or the mathematics support facility; however, if the MSC is too busy or there is limited time for the student to engage with this facility, it can be detrimental to supporting the student. In addition, if the student is not aware that there is support available, this can be daunting and gives the student limited options in seeking help with mathematics.

Test Situation

The mode of examination may not be conducive to enabling the learning of mathematics, for example online quizzes require the answer, rather than encouraging the student to engage with the method. Having difficulty answering a question and not knowing what the correct approach in an examination is, can lead to frustration and anxiety.

Additional comments

There is an emphasis on passing the examination – getting to the pass mark of 40%, and even lower if possible in order to pass by compensation. It seems like passing is enough rather than striving to do better or engaging further with the mathematics content in order to understand it and see a relevance to it. There is also a sense of strategic planning in respect of passing, with the student being aware of how many marks they can accumulate in advance of their terminal examination, so they know how much they need to strive for in the examination itself.

Over time, some of the students have avoided mathematics and engagement with mathematics when that was possible; taking the lowest ability stream in secondary school (Foundation level), not opting to do subjects with a mathematics or mathematics-related component, dropping out of or deferring a course because of mathematics, or considering asking someone else to do tasks involving mathematics rather than face them themselves.

Incidents that impacted on the students individually include the failure of a state examination which left a negative impact on Tina, as well as a sense of cynicism in respect of the content of mathematics examination papers; Pat’s reluctance to let a scribe assist him in his mathematics examination due to the added pressure he would feel; and the mode of examination of some modules as experienced by James, who feels he did not learn much about the mathematics examined through online quizzes.

There is a strong emphasis among these students on getting an answer and getting the right answer. This is accompanied by a discourse around the importance of getting – or
the need to get – an answer in mathematics. The significance of times tables is evident among these students, and it seems to mark a turning point for them in respect of finding mathematics challenging or impacting on their self-esteem around mathematics.

These students have experienced minimal amounts of help and support with mathematics through the years for various reasons, and this is coupled with a sense of being lost with mathematics and not understanding the subject. Their levels of mathematics evaluation anxiety are high, and there is a feeling of discomfort about being put on the spot in front of the other members of the class to answer a question and thereby getting ‘the right answer;’ similarly, there is a feeling of intimidation combined with a reluctance to ask questions in class and a consciousness of what the others in the class might think (i.e. passing judgement). Pat exhibits the highest level of mathematics evaluation anxiety (scoring 42 out of 45) both in his MAS-UK scores as well as in his interview conversation, with admissions of panic about mathematics expressed throughout the interview dialogue (ten references). Both Gayle and James also scored highly (40 out of 45); however, while James took a strategic approach to getting through the module, Gayle left after 6 weeks, opting to defer her course, thereby avoiding mathematics. Tina also scored highly (39 out of 45).

These students have come through the education system without fully understanding mathematics and without that knowledge being checked regularly by the teacher. What has happened within the classroom at each level of education has been compounded and has had an impact on the way they have engaged with mathematics and how they feel about and approach mathematics now as mature students.

7.2.2 Factor 2 Scores: Everyday/Social Mathematics Anxiety

Factor 2 examined the levels of anxiety perceived by the student in everyday situations involving using numbers and mathematics, as well as the social implications of using numbers and mathematics. Factor 2 comprises eight statements (Table 7.3) and allows a range of scores from a minimum of 8 to a maximum of 40.
Table 7.3 Everyday/Social Mathematics Anxiety Factor Statements

<table>
<thead>
<tr>
<th>Everyday/Social Mathematics Anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Adding up a pile of change</td>
</tr>
<tr>
<td>4. Being asked to add up the number of people in a room</td>
</tr>
<tr>
<td>5. Calculating how many days until a person’s birthday</td>
</tr>
<tr>
<td>8. Being given a telephone number and having to remember it</td>
</tr>
<tr>
<td>11. Working out how much time you have left before you set off for work or place of study</td>
</tr>
<tr>
<td>13. Working out how much change a cashier should have given you in a shop after buying several items</td>
</tr>
<tr>
<td>14. Deciding how much each person should give you after you buy an object that you are all sharing the cost of</td>
</tr>
<tr>
<td>22. Working out how much your shopping bill comes to</td>
</tr>
</tbody>
</table>

Figure 7.6 shows the Factor 2 scores for all 20 participants and reveals three clusters, ranging from the minimum score of 8 up to 27, indicating a moderate everyday/social mathematics anxiety score, with no student indicating a relatively higher level of anxiety for this factor.

<table>
<thead>
<tr>
<th>Cluster 1</th>
<th>Cluster 2</th>
<th>Cluster 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Lower mid</td>
<td>High</td>
</tr>
<tr>
<td>Jon, Neo, Ken, Lisa, Evan, Kate, Mike, Con, Shay and Eve</td>
<td>Mark, Lynn, Tina, Sam, Anna</td>
<td>8, 8, 8, 9, 10, 10, 10, 11, 12, 12, 14, 14, 15, 15, 16, 19, 19, 19, 22, 27</td>
</tr>
</tbody>
</table>

The three clusters are:

- Cluster 1 – low environmental/social mathematics anxiety with scores from 8 to 12 (Jon, Neo, Ken, Lisa, Evan, Kate, Mike, Con, Shay and Eve)
- Cluster 2 – lower mid-range environmental/social mathematics anxiety with scores from 14 to 16 (Mark, Lynn, Tina, Sam, Anna)
- Cluster 3 – upper mid-range environmental/social mathematics anxiety with scores from 19 to 27 (Dan, Alec, James, Gayle and Pat).

The scores are further explored below in respect of the qualitative data and findings relating to situations of mathematics. Hunt and colleagues (2011) described such situations as involving everyday numerical calculations in a social setting – in contrast to a learning environment – that may involve money, counting, and remembering numbers, as well as the social implications of engagement with such situations. A review of the qualitative data analysis is required to identify what students said in respect of engagement with mathematics and numerical calculations in these every day and social situations. Table 7.4 shows a list of relevant words sourced from the analysis of the qualitative data.

**Table 7.4 Words used to Review Situations of Everyday/Social Mathematics**

<table>
<thead>
<tr>
<th>Add+</th>
<th>Cost</th>
<th>Mental</th>
<th>Real life</th>
<th>Shop+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buy</td>
<td>Count+</td>
<td>Money</td>
<td>Relevan+</td>
<td>Time</td>
</tr>
<tr>
<td>Calculat+</td>
<td>Memorise</td>
<td>Number</td>
<td>Remember+</td>
<td>Work</td>
</tr>
</tbody>
</table>

The review of the qualitative data using the above keywords and synonyms resulted in the following findings in respect of each cluster of mature students. In a similar way to section 7.2.1.1, this section opens with a summary of relevant quantitative data and findings from the everyday/social mathematics anxiety factor, followed by the findings presented by cluster under the headings of environmental, dispositional, and situational.

**7.2.2.1 Cluster 1 – Low Everyday/Social Mathematics Anxiety**

This cluster includes ten mature students - Jon, Neo, Ken, Lisa, Evan, Kate, Mike, Con, Shay and Eve – who have low scores on the everyday/social mathematics anxiety factor. They range in ages from 24 to 49, and comprise 7 males and 3 females, with 7 from Uni and 3 from IoT. Four are studying in the Engineering, Manufacturing and Construction discipline, two in Science, Mathematics and Computing, two in Social Sciences, Business and Law, and one each in Humanities and Arts, and Education. Most of the students knew there would be a mathematics module in their programme of study, but Jon and Shay did not. Six of the students updated their mathematics knowledge before starting the programme, all of whom did the preparatory course at that HEI, and four of whom also engaged in self-study of mathematics. In the MAS-UK test, their scores ranged from 28 (Evan) to 64 (Eve). All scores from these students in the everyday/social mathematics
anxiety factor were either mostly 1s, with fewer 2s, and 3s (Figure 7.7) with no indications of the students being much (score of 4) or very much (score of 5) anxious in respect of these everyday/social situations.

Figure 7.7 Low Range Everyday/Social Mathematics Anxiety Distribution of Scores

Jon, Neo and Ken scored 1 for all items, suggesting no anxiety in such situations. In contrast, only Evan and Eve scored a three and for the same item – statement 8: ‘Being given a telephone number and having to remember it.’ Their respective MAS-UK scores represent the lowest (Evan, 28) and highest (Eve, 64) of this cluster. Three other students rated statement 8 with a score of 2, and overall this statement had the highest collective rating with a combined score of 17 from the ten students; this contrasts with the following three statements whereby all ten students rated 1 for each of three statements (a combined score of 10), suggesting no anxiety in these situations:

- 2. Adding up a pile of change
- 11. Working out how much time you have left before you set off for work or place of study
- 13. Working out how much change a cashier should have given you in a shop after buying several items

These scores suggest these students have overall low anxiety in such everyday situations and in respect of the potential social implications. The following section looks at what these students had to say about situations of everyday engagement with mathematics and numbers. In contrast to the discussion on the mathematics evaluation anxiety factor, there
was less content to analyse, and consequently there are fewer incidents to report. As with section 7.2.1 the presentation of these findings adheres to Cemen’s three categories of antecedents: environmental, dispositional, and situational, with relevant subheadings.

**Significant Incidents representing Environmental Antecedents for Students with Low Everyday/Social Mathematics Anxiety**

*Past Experiences*

These students acknowledge that mathematics featured in the work they did before enrolling in HE, and that it was important within the roles undertaken; however, there is a sense that much of the usage of mathematics was at a basic level, and where mathematics got more complicated, it was left to other – usually higher-ranking – staff to deal with. For some students there was a requirement to use mental arithmetic at work, and often at a fast pace. Negative experience with mental arithmetic at primary school negatively impacted one student’s engagement with it in later life.

**Significant Incidents representing Dispositional Antecedents for Students with Low Everyday/Social Mathematics Anxiety**

*Attitudes to Mathematics*

These students have an appreciation for mathematics in everyday life, and that motivates them to be competent in mathematics. Being able to see the relevance of mathematics to everyday life is important in grasping and retaining mathematics concepts. There is an awareness among these students that mathematics is an essential part of many aspects of everyday life and will be a useful skillset for future career prospects.

**Significant Incidents representing Situational Antecedents for Students with Low Everyday/Social Mathematics Anxiety**

*Mathematics as a Subject*

Two of these students perceive a difference between mathematics as an academic subject – or ‘the non-everyday stuff’ – and how they use mathematics everyday – or ‘normal maths.’
Additional Comments

All experiences in the workplace conveyed by the students have involved the use of mathematics in various guises, and for various techniques. This exposure to the use of mathematics in a work context has helped increase confidence with mathematics. In spite of this, some of the students did not identify this use of mathematics as being academic mathematics, but everyday mathematics.

7.2.2.2 Cluster 2 – Lower Mid-Range Environmental/Social Mathematics Anxiety

This cluster has five mature students – Mark, Lynn, Tina, Sam and Anna – who have scores from 14 to 16 out of a maximum of 40 on the everyday/social mathematics anxiety factor. The students comprise three females and two males, with ages ranging from 27 to 47. Lynn is from the Uni sector and the others are from the IoT sector. Two each study in the disciplines of Engineering, Manufacturing and Construction and Science, Mathematics and Computing, and one studies in the discipline of Education. Three of the students knew about the mathematics component in their programmes, and of these only one prepared in advance through self-study of mathematics. In the MAS-UK test, their scores ranged from 52 (Mark) to 67 (Sam). Figure 7.8 shows the allocation of scores for each student in the everyday/social mathematics anxiety factor.

Figure 7.8 Lower Mid-Range Everyday/Social Mathematics Anxiety Distribution of Scores

Most students’ scores cluster around scores of 1 and 2, with Mark scoring the only 4 and Sam scoring the only 5, both of which were given for statement 8 ‘Being given a telephone
number and having to remember it.’ This statement scored a three from Lynn, and a 2 from Tina and Anna, thereby presenting at least slight anxiety among this cluster. The next statement which scored relatively highly was statement 14: ‘Deciding how much each person should give you after you buy an object that you are all sharing the cost of’, with one score of 3, three scores of 2, and one score of 1. The statement causing the least amount of anxiety was statement 2: ‘Adding up a pile of change,’ which received one score of 2 and four scores of 1.

These scores suggest these students have relatively low anxiety in such everyday situations and in respect of the potential social implications. The following section looks at what these students had to say about situations of everyday engagement with mathematics and numbers.

**Significant Incidents representing Environmental Antecedents for Students with Lower Mid-Range Everyday/Social Mathematics Anxiety**

*Past Experiences*

Among these students there was an awareness of the importance of knowing the right calculations in different work situations and getting these right. More complicated scenarios usually required more complex mathematics capability. Not being able to grasp the more complicated mathematics led to a preference to avoid the situation and leave the task to another work colleague with more expertise. For some students their work experience required dependence on the calculator due to the nature of the calculations involved. For others their line of work did not require them to engage with mathematics, resulting in them not using it and forgetting it.

**Significant Incidents representing Dispositional Antecedents for Students with Lower Mid-Range Everyday/Social Mathematics Anxiety**

*Confidence*

The extent of engagement with mathematics in the workplace impacted positively on some students’ confidence with mathematics, particularly where calculations had to be done at a fast pace.
Relevance of Mathematics

These students feel comfortable with mathematics when they can see its relevance to everyday situations and real life. Being able to visualise problems in real-life contexts helps in this regard. There is a sense that the logic of mathematics helps with problem-solving in any situation. However, there is also a belief that there is a difference between academic mathematics and more practical usage.

Significant Incidents representing Situational Antecedents for Students with Lower Mid-Range Everyday/Social Mathematics Anxiety

Presenting a Context for the Subject

For some students doing mathematics without a context can be challenging, especially when they cannot understand its application to an everyday scenario.

Additional Comments

There was an awareness of the importance of getting the mathematics right in the work context, and not being able to do this led to a preference not to engage with it or avoidance of mathematics as much as possible. Where mathematics was perceived in a positive light it impacted positively on confidence and pace of doing calculations. Being able to grasp the relevance of mathematics is central to understanding, and visualisation of the problem is helpful; however, there is a perception that everyday mathematics is different to academic mathematics.

7.2.2.3 Cluster 3 – Upper Mid-Range Environmental/Social Mathematics Anxiety

This section looks at the findings for the cluster of five mature students – Dan, Alec, James, Gayle and Pat – who have scores from 19 to 27 out of a maximum of 40 on the everyday/social mathematics anxiety factor. The students comprise four males and one female, with ages ranging from 34 to 39. Two are from the Uni sector and three from the IoT sector. Two each study in the disciplines of Engineering, Manufacturing and Construction and Humanities and Arts, and one studies in the discipline of Science, Mathematics and Computing. All of the students knew about the mathematics component in their programmes; however, only one – Dan – prepared in advance by attending a preparatory course at the HEI, as well as through self-study of mathematics. In the MAS-UK test, their scores ranged from 56 (Dan and Alec) to 94 (Pat). Figure 7.9 shows the allocation of scores for each student in the everyday/social mathematics anxiety factor.
Most of the scores cluster around scores of 1 to 3, with 3s being the most common choice among this group. Statement 8 – ‘Being given a telephone number and having to remember it’ – had the highest scores with three 4s and two 5s, suggesting this situation causes these students most anxiety in an everyday/social context.

![Figure 7.9 Upper Mid-Range Everyday/Social Mathematics Anxiety Distribution of Scores]

The only other statement with no 1 scores was statement 5: ‘Calculating how many days until a person’s birthday’ with one 2 and three 3s, suggesting varying levels of anxiety for this activity as well as the social implications of not getting the count right, and potentially forgetting someone’s birthday. In contrast, statement 2: ‘Adding up a pile of change’ had the lowest scores, with one score of 1, three 2s, and one 3. This was followed by statement 4: ‘Being asked to add up the number of people in a room’, with one score of 1, two 2s and two 3s. Alec was the only one of this cluster not to score 5 for any statement. In contrast, neither Gayle nor Pat scored 1 for any statement; Gayle’s scores ranged from 2 to 4, and Pat’s ranged from 2 to 5, suggesting anxiety of varying levels in all such situations.

These scores suggest these students have varying levels of anxiety in such everyday situations and in respect of the potential social implications. The following section looks at what these students had to say about situations of everyday engagement with mathematics and numbers.
Significant Incidents representing Environmental Antecedents for Students with Upper Mid-Range Everyday/Social Mathematics Anxiety

Past Experiences

Each of these students had exposure to using mathematics in a workplace context, with some using mathematics more than others. In some cases, there was a perception that only a very basic level of mathematics was required, while for others it was important to be shown exactly what measurements and calculation needed to be done.

Significant Incidents representing Dispositional Antecedents for Students with Upper Mid-Range Everyday/Social Mathematics Anxiety

Attitudes to Mathematics

Being able to relate the mathematics to something useful and relevant helps some of these students in grasping the mathematical concepts. However, some students do not see every day uses of numbers as mathematics. For one student the pursuit of a sailing course was cut short when she realised there were calculations involved, which she had not anticipated. With abstract concepts like algebra it can be difficult to see the relevance to everyday life, and there is a perception that it is not used every day.

Prior Avoidance

One student has avoided dealing with numbers in many aspects of her daily life, including in her business run from home, whereby she has an accountant to do the books, despite admitting that it is very basic. She also cannot calculate discounts in shops and avoids such calculations.

Significant Incidents representing Situational Antecedents for Students with Upper Mid-Range Everyday/Social Mathematics Anxiety

Mathematics as a Subject

There is a perception that mathematics may not be entirely necessary in future workplace scenarios, as software programs can do much of the mathematics involved, especially in respect of engineering.
Additional Comments

All students had exposure to mathematics in the workplace, however some engaged with it more than others, and being shown how to do it was very important to grasping the mathematics. Some students do not see the everyday uses of mathematics as being the same as academic mathematics, and there is a perception that algebra is not relevant to everyday life. The need for mathematics in the workplace is questioned as software programs can do the calculations.

7.2.3 Factor 3 Scores: Mathematics Observation Anxiety

Factor 3 examined the levels of anxiety perceived by the student in situations of observation and passive engagement with mathematics. Factor 3 comprises 6 statements (Table 7.5) and allows a range of scores from a minimum of 6 to a maximum of 30.

<table>
<thead>
<tr>
<th>Mathematics Observation Anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Reading the word ‘algebra’</td>
</tr>
<tr>
<td>12. Listening to someone talk about maths</td>
</tr>
<tr>
<td>15. Reading a maths textbook</td>
</tr>
<tr>
<td>16. Watching someone work out an algebra problem</td>
</tr>
<tr>
<td>17. Sitting in a maths class</td>
</tr>
<tr>
<td>20. Watching a teacher/lecturer write equations on the board</td>
</tr>
</tbody>
</table>

Factor 3 comprises six statements and allows a range of scores from a minimum of 6 to a maximum of 30. Figure 7.10 shows the Factor 3 scores for all 20 participants and reveals three clusters of scores, ranging from the minimum of 6 up to a high score of 28. The three clusters are:

- Cluster 1 – low mathematics observation anxiety with scores from 6 to 8 (Evan, Lisa, Con, Neo, Mike, Ken and Dan)
- Cluster 2 – mid-range mathematics observation anxiety with scores from 12 to 18 (Tina, Shay, Anna, Mark, Alec, Lynn and Kate)
- Cluster 3 – high mathematics observation anxiety with scores from 21 to 28 (Sam, Eve, James, Gayle, Pat and Jon).
The scores are further explored below in respect of the qualitative data and findings relating to situations of mathematics observation and passive engagement with mathematics. Hunt and colleagues (2011) described such situations as involving observation of mathematics without any direct calculation, testing or manipulation of numbers on the part of the student. A review of the qualitative data analysis is required to identify what students said in respect of such situations. Table 7.6 shows a list of relevant words sourced from the analysis of the qualitative data.

**Table 7.6 Words used to Review Situations of Mathematics Observation**

<table>
<thead>
<tr>
<th>Algebra</th>
<th>Explain</th>
<th>Listen</th>
<th>Sit</th>
<th>Watch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Board</td>
<td>Follow</td>
<td>Look</td>
<td>Talk</td>
<td>Website</td>
</tr>
<tr>
<td>Book</td>
<td>Formula</td>
<td>Online</td>
<td>Teacher</td>
<td>Write</td>
</tr>
<tr>
<td>Class</td>
<td>Hear</td>
<td>Read</td>
<td>Tutor</td>
<td></td>
</tr>
<tr>
<td>Equation</td>
<td>Lecturer</td>
<td>See</td>
<td>Video</td>
<td></td>
</tr>
</tbody>
</table>

The review of the qualitative data using the above keywords and synonyms resulted in the following findings in respect of each cluster of mature students. In a similar way to
previous sections (7.2.1.1 and 7.2.2.1) the findings are presented by cluster, preceded by a summary of relevant quantitative data and findings from the mathematics observation anxiety factor.

7.2.3.1 Cluster 1 – Low Mathematics Observation Anxiety

This cluster includes seven mature students – Evan, Lisa, Con, Neo, Mike, Ken and Dan – who have low scores on the mathematics observation anxiety factor. They range in ages from 24 to 46, and comprise 6 males and 1 female, with 4 from Uni and 3 from IoT. Five are studying in the Engineering, Manufacturing and Construction discipline, and two in Science, Mathematics and Computing. All of the students knew there would be a mathematics module in their programme of study, and all but one updated their mathematics knowledge before starting the programme; these six students did the preparatory course at that HEI, and four of them also engaged in self-study of mathematics. In the MAS-UK test, their scores ranged from 28 (Evan) to 56 (Dan). The scores from these students in the mathematics observation anxiety factor were mostly 1s, with a few 2s (Figure 7.11) with no indications of the students being ‘a fair amount’ anxious, much (score of 4) or very much (score of 5) anxious in respect of these situations of mathematics observation.

![Figure 7.11 Low Mathematics Observation Anxiety Distribution of Scores](image-url)
Evan, Lisa and Con scored all 1s, suggesting no anxiety in such situations. Four of the 2s were given to statement 15 ‘Reading a maths textbook.’ Overall these students demonstrated low or no mathematics observation anxiety.

**Significant Incidents representing Environmental Antecedents for Students with Low Mathematics Observation Anxiety**

*Parental Encouragement*

The presentation of mathematics by parents of these students was done in a fun way and helped them to visualise the problems easily, facilitating understanding.

*Past Experiences*

For these students the role of the teacher was portrayed in a negative light; a poor first impression set the tone for subsequent classes; the teacher would get frustrated with students asking questions, and as a result students did not ask any more but did not understand the mathematics; the teacher’s inability to explain concepts impacted on students’ engagement with the subject, resulting in some students availing of private tuition. A change of teacher brought a different approach to presenting the mathematics, adding to the anxiety felt by students.

**Significant Incidents representing Dispositional Antecedents for Students with Low Mathematics Observation Anxiety**

*Approach to Preparation*

In respect of LC OL mathematics some students observed that if you paid attention in class you would grasp most of the concepts and could pass the subject. The use of textbooks was recalled as challenging for these students, in that reading the textbook alone may not have made sense, resulting in an inability to work out the problems. In addition, having someone showing you how to work out the problems was considered more effective than reading a textbook.

*Attitudes to Mathematics*

There is consensus among these students that mathematics is very important for their everyday lives and will feature significantly in their future careers. The experience of mathematics in HE has been largely positive in that the modules show the relevance of mathematics to the discipline of study, although for one student the purpose of a statistics
module in an engineering programme was not made clear and was not appreciated by the student.

**Significant Incidents representing Situational Antecedents for Students with Low Mathematics Observation Anxiety**

*Classroom Factors*

Watching the lecturer write equations on the board was challenging because the concepts were abstract, the context was not clear, and the pace was too fast, with the expectation that students got it straight away, whereas some students need more time to digest and grasp these concepts. In addition, some lectures were too long, causing a loss of interest and stamina.

*The Way Mathematics is taught*

The ability of the lecturer to explain the concept well facilitates a positive understanding and impression of mathematics.

*Test Situation*

For some students the way examination questions are written poses a problem, as they are different to what is experienced in the lecture; there is a sense that the lecturer is trying to trick the student. Not being able to move beyond a certain point in doing a mathematics problem can cause anxiety and panic, particularly in an examination context. In addition, where a student’s first language is not English, the wording of examination questions can pose additional challenges for those students.

*Additional Comments*

For these students, parents had a positive disposition towards mathematics which came across in the ways they explained mathematics to their children. In contrast, experiences with the teachers at second level were less favourable, with poor first impressions setting the tone for the class, as well as the teacher’s perceived inability to explain and apparent frustration at being asked questions in class. The importance of paying attention in class was viewed as productive for understanding mathematics and having the assistance of someone else to show you how to do the mathematics. In HE, there is a sense that mathematics lectures are challenging, with the presentation of some concepts sometimes lacking context and clarity, as well as being delivered at too fast a pace. Where the
mathematics is explained within a context it facilitates understanding and a positive impression of mathematics.

7.2.3.2 Cluster 2 – Mid-Range Mathematics Observation Anxiety

This cluster also includes seven mature students – Tina, Shay, Anna, Mark, Alec, Lynn and Kate – who have mid-range scores on the mathematics observation anxiety factor. They range in ages from 26 to 47, and comprise 4 females and 3 males, with 4 from IoT and 3 from Uni. Three are studying in the Engineering, Manufacturing and Construction discipline, two in Social Sciences, Business and Law, and one each in Science, Mathematics and Computing, and Education. Four of the students knew there would be a mathematics module in their programme of study, but only two of these updated their mathematics knowledge before starting the programme; one did the preparatory course at that HEI, and one engaged in self-study of mathematics. In the MAS-UK test, their scores ranged from 48 (Shay) to 66 (Tina). All but one score from these students in the mathematics observation anxiety factor were 1s, 2s or 3s (Figure 7.12) with no scores of 4 and only one score of 5 (Kate) in respect of these situations.

![Figure 7.12 Mid-Range Mathematics Observation Anxiety Distribution of Scores](image)

Only Tina, Shay and Anna scored 1s; the other students had scores of 2 or higher, with Kate being the only one giving a score of 5. Lynn gave scores of 3 to all statements, while
Mark gave 2s to all but one statement. The statement with highest scores was statement 20 ‘Watching a teacher/lecturer write equations on the board’ (combined score of 21), followed by Statement 15 ‘Reading a maths textbook’ (combined score of 21).

**Significant Incidents representing Environmental Antecedents for Students with Mid-Range Mathematics Observation Anxiety**

*Past Experiences*

There is awareness among these students of what constitutes effective teaching methods, and the impact these have on how well you grasp concepts. In addition, where confidence is lacking among students this can lead to uncertainty in how well they are attempting a problem, and not being able to ascertain if what they have done is right or wrong can be frustrating.

**Significant Incidents representing Dispositional Antecedents for Students with Mid-Range Mathematics Observation Anxiety**

*Attitudes to Mathematics*

Seeing the relevance of the mathematics they encounter in class is important for these students. Observing formulas out of context can be confusing, and abstract concepts like algebra are difficult to relate to the real world. When one student could not understand the mathematics behind what his boss was showing him, he was not asked to do that task again.

**Significant Incidents representing Situational Antecedents for Students with Mid-Range Mathematics Observation Anxiety**

*Mathematics as a Subject*

Watching the lecturer and not understanding what is being written on the board leads to frustration among these students. Many of them resort to using supplemental resources like textbooks and online videos with instructions. These resources such as YouTube and Khan Academy allow the student to observe and follow explanation of the desired mathematics concepts at their own pace.
Classroom Factors

The lecture can have a fast pace with a lot of material being presented, with little chance to digest the content or ask questions. In contrast the tutorial has a more favourable pace, with fewer numbers in attendance, and scope to ask questions and talk to the tutor on an individual basis.

Additional Comments

There is an awareness of how good teaching methods can have an impact on how well you can grasp the subject. However, lack of confidence can lead to uncertainty in one’s approach to solving a problem. Observing formulas, and abstract concepts can cause confusion as these are difficult to relate to the real world. The pace of lectures and volume of material is often a lot to digest, and tutorials offer a favourable opportunity to work through problems. Students will use online resources and textbooks to supplement their understanding of mathematics as they can work at their own pace with these.

7.2.3.3 Cluster 3 – High Mathematics Observation Anxiety

This cluster includes six mature students – Sam, Eve, James, Gayle, Pat and Jon – who have high scores on the mathematics observation anxiety factor. The students range in ages from 27 to 49, and comprise 4 males and 2 females, with 3 each from Uni and IoT. Three are studying in the Humanities and Arts discipline, two in Science, Mathematics and Computing, and one in Education. All of the students except Jon knew there would be a mathematics module in their programme of study, however, none of the students updated their mathematics knowledge before starting the programme. In the MAS-UK test, their scores ranged from 59 (Jon) to 94 (Pat). All scores from these students in the mathematics observation anxiety factor were combinations of 3s, 4s, and 5s (Figure 7.13), indicating considerable anxiety in respect of these situations of mathematics observation.
Jon had the highest individual score comprising four 5s and two 4s. The highest scoring statements were Statements 9 ‘Reading the word ‘algebra’ and 20 ‘Watching a teacher/lecturer write equations on the board,’ with combined scores of 26 each; these were followed closely by Statement 17 ‘Sitting in a maths class,’ with a combined score of 25.

It is noteworthy that Jon’s three individual scores for the three factors have fluctuated and say different things about Jon’s mathematics anxiety, ranging from the lowest score in the Everyday/Social Mathematics anxiety factor, to a lower mid-range score in the Mathematics Evaluation anxiety factor, and the highest score in the mathematics observation anxiety factor; his overall MAS-UK score was 59, which – by itself – does not show any indication of Jon’s high level of anxiety towards mathematics in situations of observation. For Jon it is evident that certain circumstances cause more anxiety than others; while he has no issue with everyday or social situations involving mathematics, Jon has moderate anxiety in situations of mathematics evaluation, and high anxiety in situations of mathematics observation.
Significant Incidents representing Environmental Antecedents for Students with High Mathematics Observation Anxiety

Past Experiences

For these students, high mathematics observation anxiety stemmed from watching the good kids in class succeed while these students were unable to answer questions and did not know why they got a question wrong. Not understanding what was going on in class added to the pressure felt by some students, and this was not picked up by the teacher. In addition, the pace at which topics were being presented in LC class was at times too fast, without the chance to catch up, or without opportunity to ask questions, and consequently being left behind.

Significant Incidents representing Dispositional Antecedents for Students with High Mathematics Observation Anxiety

Extent of Self-Doubt

Sitting in a mathematics class stirs up strong negative feelings for some students, leading to panic when faced with mathematics, and discomfort sitting in a mathematics class, due to feeling lost. Despite needing to ask questions, there is no opportunity for fear of looking stupid in front of one’s peers. For students with a history of negative experiences and avoidance entering a mathematics class in HE for the first time can be terrifying.

Significant Incidents representing Situational Antecedents for Students with High Mathematics Observation Anxiety

Mathematics as a Subject

For these students, algebra is a very difficult topic to grasp; it is considered mysterious and non-sensical, as there is no understanding of how or why letters and numbers can be combined. The MSC is a positive experience in this regard, but the concept of algebra is still elusive to some students. Textbooks are useful to some students, but other more anxious students are inclined to not engage with them. Online resources are also beneficial allowing students to go at their own pace.

The Way Mathematics is taught

Positive learning experiences among these students have been as a result of the lecturer using relevant examples to explain concepts, as well as supplementing the lecture with
additional notes for students. However, the reverse is also the case, whereby students who could not grasp concepts nor having access to additional notes found the mathematics more difficult. Students who avail of the MSC praise the approach of staff to facilitate the students’ understanding by breaking the problem into pieces.

Test Situation

Where a student has a learning difficulty – such as dyslexia – it can add pressure to an already stressful situation in respect of understanding mathematics. However, this student has learned to cope in situations of examination by taking his time and thinking about the questions without rushing. It is also possible that the non-diagnosis of this student’s dyslexia during his school years has contributed to his high level of mathematics anxiety in HE.

Additional Comments

For these students, noticing how well other children were doing at mathematics combined with the lack of understanding of what was going on in mathematics class led to pressure and an inability to catch up to the level of their peers. Algebra was a difficult subject to grasp. Textbooks can be difficult to read, but online resources are beneficial for controlling the pace of learning. The staff at the MSC are praised for their approach to explaining mathematics, but not all students are aware of the service or avail of it. Having a learning difficulty can result in added pressure in examination contexts, but the student has learned to pace himself and think about the questions.

7.3 Summary

Section 7.2 aimed to address research question 2: What are the significant incidents that give rise to the type and level of mathematics anxiety experienced by these mature students? In this regard the research question was addressed by combining the quantitative data from the MAS-UK scores for the twenty mature students with their corresponding qualitative life story interview data. The integration of data sets allowed for the interpretation of the results to be considered in order to elucidate those significant incidents that have given rise to the type and level of mathematics anxiety experienced. These incidents were categorised by mathematics anxiety factors – Mathematics Evaluation Anxiety, Everyday/Social Mathematics Anxiety, and Mathematics Observation Anxiety – and for each factor the environmental, dispositional and situational
antecedents that impact on each factor of mathematics anxiety are presented in the following sections.

**Mathematics Evaluation Anxiety**

*Environmental antecedents*

Environmental antecedents included parental encouragement, past experiences, and falling behind/inability to catch up. The role of the parent featured across levels of mathematics anxiety experienced with varying degrees of involvement, and with the mother’s involvement being positively conveyed. Past experiences comprised primary school experiences and secondary school experiences. Recollections of doing mathematics at primary school elicited mixed feelings across the levels. All students made reference to times tables as being a significant part of their primary school mathematics experience. Feeling about mathematics at primary school ranged from fun experiences of doing mathematics to recollections of intimidation and punishment, and the public display of a lack of knowledge of the mathematics topics.

At secondary school the theme of intimidation by the teacher also featured for some students. The context for JC and LC mathematics was frequently not clear to these students, and the abstractness of some concepts posed problems. There was an emphasis on getting the right answer and within a timeframe, suggesting an environment not conducive to learning. Algebra was recalled as being mysterious and abstract for these students.

The sense of falling behind was experienced across the levels. The streaming of mathematics classes and allocation of students to these different levels had a delayed impact on career options. There was an awareness that the mathematics topics were getting more and more difficult.

*Dispositional Antecedents*

Dispositional antecedents included extent of self-doubt, attitudes to mathematics, and prior avoidance. Expressions of self-doubt varied among the students and included comment on their ability and confidence in mathematics, as well as their approach to preparation and the impact of failure. All these students experienced failure in mathematics and this has impacted upon them in different ways, ranging from motivating
them to do better, to leading them to avoid mathematics as much as possible and doing enough to get by.

Seeing the relevance of mathematics helps significantly with understanding, and that might mean going back to the basics, or trying to interpret it in simpler English. All of these students view mathematics as an important subject; however, many students believe module titles are disguised. Where there is a tendency to avoid mathematics, there is a preference to avoid programmes with mathematics content; however, the title of the programme may not reflect an association with mathematics. There is evidence that repeated avoidance of mathematics has led to a far-reaching negative impact on the students’ engagement with mathematics.

_Situational Antecedents_

Situational antecedents included mathematics as a subject, classroom factors, the way mathematics is taught, and the test situation. There are varying levels of comfort with mathematics among these students, ranging from satisfaction among lower mathematics anxious mature students to uncertainty of their ability among high mathematics anxious students, and a need for reassurance from others with mathematics.

Among all these students there is an assertion that class (lecture) sizes are too big, resulting in them not being able to ask questions of the lecturer. These mature students prefer personal contact – meeting the lecturer after class – rather than electronic contact (email) with the lecturer. Also, not having time to do the mathematics problems causes problems for these students.

In terms of the way mathematics is taught, lecturers are generally perceived as approachable, capable and having a good rapport with students. The Mathematics Support Centre (MSC) is seen as beneficial to many mature students, as the staff talk to them individually, having time to explain the concepts, and these students attend regularly during the term. However, others experienced the MSC differently, in that it can be too busy, and the time is limited in which to ask questions. However, not all of these students were aware of the MSC facility at their HEI. If students are not aware of the MSC it can lead to added pressure, giving them limited options for support. Peer support is also significant to these students.
In the test situation, these students have a variety of strategies; however, knowing how you have fared in the continuous assessment component is beneficial for preparation for the examination. However, some modes of examination, i.e. online quizzes, may not be conducive to understanding mathematics. In the examination not knowing the correct approach to take causes confusion, anxiety, and panic.

**Everyday/Social Mathematics Anxiety**

*Environmental Antecedents*

Environmental antecedents comprised past experiences relating to using mathematics in a work context. Mathematics was perceived as important within work situations, with mathematics being used in different ways with different levels of complexity. There was an emphasis on the importance of getting the calculations right, but for some, there was a preference not to have to do the mathematics, and a reliance on others to help or to do the mathematics instead.

*Dispositional Antecedents*

Dispositional antecedents included attitude to mathematics, confidence, relevance of mathematics, and prior avoidance. Exposure to mathematics in a workplace has been beneficial to confidence, and being able to experience the relevance of mathematics has been important for understanding the subject, with visualisation being useful in this regard.

*Situational Antecedents*

Situational antecedents included mathematics as a subject, and the context for mathematics. Some students do not see everyday mathematics as the same as academic mathematics, with topics like algebra seen as not relevant to everyday life. The ability of software programs to do many mathematical tasks poses the question among some students regarding the need for formal mathematics learning.

**Mathematics Observation Anxiety**

*Environmental Antecedents*

Environmental antecedents comprised parental encouragement and past experiences. For some of these students a positive parental disposition was looked on favourably in helping their engagement with mathematics. This contrasted with these students’ experiences of
many teachers, whereby a good grasp of the subject was acknowledged as being dependent on good teaching methods.

**Dispositional Antecedents**

Dispositional antecedents included approach to preparation, attitude to mathematics, and extent of self-doubt. Paying attention in class was viewed as important to understanding mathematics, as was having help from someone to show you how to do mathematics. However, a lack of confidence resulted in uncertainty in how one approached mathematics.

**Situational Antecedents**

Situational antecedents included classroom factors, the way mathematics was taught, mathematics as a subject, and the test situation. In HE service mathematics lectures sometimes lack an obvious context which makes the topics challenging. The pace of lectures and volume of content can be difficult to adjust to. There is a tendency among these students to rely on online resources to supplement their learning of mathematics topics. Tutorials and the mathematics support centre are both viewed as supportive with mathematics, but not all students avail of these. Examination situations can be challenging particularly when a student has a learning difficulty, but effective strategies with mathematics can help to overcome these challenges.

**7.4 Conclusion**

This chapter has presented the results that address the two research questions of the study. The results for RQ1 were quantitative and comprised the compilation of responses by 107 mature students across four Irish HEIs who completed the questionnaire. The results for RQ2 emerged from the integration of questionnaire results and life story interview findings for the twenty mature students who opted in to be interviewed. The integration of quantitative and qualitative results in this manner allowed the responses by mature students with low, mid-range and high levels of mathematics anxiety to elucidate those situations behind their corresponding MAS-UK scores, thereby allowing a deeper insight into the incidents that may have contributed to their mathematics anxiety. The combination of the results for RQ1 and RQ2 provide useful insights into the nature of mathematics anxiety among these mature students and provide the backdrop for chapter 8: the discussion.
Chapter 8 Discussion
8.0 Introduction

The aim of this research was to investigate the extent and derivation of mathematics anxiety among mature students in Ireland. Having addressed the two research questions in chapter 7, it is evident that mathematics anxiety does exist among mature students, and for this cohort, it ranges from very low levels to considerable levels of anxiety. The extent of mathematics anxiety among these students is influenced by a number of factors that draw from a combination of environmental, dispositional, and situational antecedents. These headings – environmental, dispositional, and situational – are used to structure the discussion chapter, thereby presenting the discussion around the significant incidents in each set of antecedents that contributed to varying levels of anxiety as expressed by these mature students.

8.1 Environmental Antecedents

Drawing on Cemen’s (1987) Model of a Mathematics Anxiety Reaction, environmental antecedents comprise the role of parents; past experiences – including primary school, secondary school, and the respective teachers – as well as work experience, which is an additional consideration for the mature students in this study, as they all had past work experience which involved using mathematics in some form or other; and mathematics achievement below expectation.

8.1.1 The Role of Parents

The supportive role of the parent in their child’s learning of mathematics has a positive impact on how their child engages with the subject (Goodall et al., 2017; McMullen & DeAbreu, 2011). For the students in this study, differences emerged among the different levels of mathematics anxiety in respect of parental encouragement and involvement, a finding which concurs with recent research (Batchelor et al., 2017; Goodall et al., 2017). The parents of mature students with low MA were presented as having a positive disposition and enthusiasm towards mathematics, helping their children to facilitate understanding. For mid-range MA students, the support of the mother conveyed a positive impression of mathematics. However, parents’ fixed mindset, infliction of punishment for failure, and demands for high achievement detracted from the positive experiences with mathematics. In contrast, parental encouragement was mostly lacking among high mathematics anxious mature students, and where parents were involved there was evidence of interest in the outcome of learning – getting the answer – rather than
facilitating understanding. There was also an awareness across the levels of MA that the extent of help was dictated by the level of education of the parents themselves. The negative experiences of parental involvement conveyed by the mid-range and high mathematics anxious students resonate with the literature on the impact of – particularly negative – attitudes and beliefs of parents about mathematics and how these can have a detrimental effect on their children’s engagement with the subject (Goodall et al., 2017; Maloney et al., 2015; Zaslawsky, 1998). In consideration of the contention that positive parental involvement contributes to the reduction of mathematics anxiety (Vukovic et al., 2013b) the current findings endorse the need to support parents in their efforts to assist their children with mathematics, echoing findings by Morkoyunlu, Konyalioglu and Gedik (2018).

8.1.2 Past Experiences – Primary School

For many mature students, the difficulties associated with engagement with mathematics at higher education have their roots in past school experiences, where students’ attitudes towards mathematics have been shaped and compounded (Geist, 2010), with specific components of their schooling being pivotal in the onset and development of their anxiety towards mathematics (Beilock & Willingham, 2014). For most mature students in this study, doing mathematics at primary school was recollected positively, with the memory of doing times tables mentioned frequently. For low and mid-range mathematics anxious students, engagement with mathematics was recalled as fun, with a sense of enthusiasm for the subject, and much support with mathematics, all of which contributed to confidence in mathematics. Times tables were recalled as having to be learned by heart, but there was no negativity expressed about this.

In contrast, for those high mathematics anxious students the experience of doing mathematics was conveyed as negative and fearful, including lack of understanding and not catching up, comparison with other children – particularly the ‘good kids’ and the public display of one’s lack of knowledge of mathematics. The experiences of these highly anxious students reflect the contention that their anxiety towards mathematics went undetected and unnoticed. As they recalled, the school environment allowed no opportunity for them to express their fear and anxiety towards the subject, reflecting findings by Chaman and colleagues (2014) and Ganley & McGraw (2016); it is likely
that as primary school students they were unable to express effectively their feelings about mathematics.

8.1.3 The Role of the Primary School Teacher

The role of the teacher contributes significantly to the attitudes and level of engagement with mathematics (Gough, 1954; Gunderson et al., 2012; Maloney & Beilock, 2012). For these mature students the primary school teacher played a substantial role in how they engaged with the subject; students with low and mid-range mathematics anxious had largely positive recollections of the teacher, while the converse is the case for high mathematics anxious students, with recollections of incidents of intimidation by the teacher, including having to stand up in front of the class to answer questions, and a lack of support with mathematics, thereby contributing to the development of their negative attitudes towards mathematics (Boaler, 2016; Maloney & Beilock, 2012). Considering that the onset of these mature students’ negative attitudes in mathematics are attributable to their primary school experiences of doing mathematics, this finding lends itself to the need to ensure that mathematics anxiety is detected among primary school children (Ganley & McGraw, 2016; Ramirez et al., 2013). In this regard, the role of the teacher is significant in facilitating the detection of mathematics anxiety from early on in the child’s engagement with mathematics right through their primary schooling, in order that the development and establishment of mathematics anxiety is counteracted (Beilock et al., 2010; Boaler, 2010; Ganley & McGraw, 2016; Wigfield & Meece, 1988). This may also necessitate the teacher availing of professional development to address their own concerns and anxiety towards mathematics (Boaler, 2010; Geist, 2010; Vukovic et al., 2013b).

8.1.4 Past Experiences – Secondary School

A variety of challenges face students engaging with mathematics at secondary school, including a new curriculum, abstract concepts, streaming, and preparation for state examinations (Boaler, 2000; Ní Shúilleabháin, 2014; Smyth, 2017). For these mature students their recollections of experiences of secondary school mathematics were presented as largely negative. Across the levels of mathematics anxiety the students expressed recollections of a lack of support with – and uncertainty in doing – mathematics, which manifested itself in various ways; for example, timetabling of classes sometimes days apart (low MA); not understanding the context for mathematics (mid-
range MA), as well as the abstractness of some topics, like geometry (mid-range MA) and algebra (high MA); not asking questions in front of your peers, the challenge of time limitations, not knowing if you are doing the work right and getting stuck with examination questions (high MA); however one high mathematics anxious student acknowledged that the pursuit of an answer can be motivating. These recollections suggest the students felt very much on their own engaging with mathematics; they were unsure of what they were doing and were unable to ask the teacher for help; for some students this was their experience since the first year in secondary school and throughout their time there. In addition, the introduction of new more challenging concepts meant some students found it difficult to keep up with the pace and fell behind, echoing findings by Jackson and Leffingwell (1999) and Geist (2010). As with the primary school recollections the role of the teacher had a significant impact on these mature students’ experiences, as will now be elaborated upon.

8.1.5 The Role of the Secondary School Mathematics Teacher

For most of these mature students, recollections of their impressions of the secondary school mathematics teacher presented the teachers in a negative light, which can have an adverse impact upon how students engage with mathematics (Hadfield & McNeil, 1994; Maloney & Beilock, 2012; Perry, 2004). It is noteworthy that both low and high mathematics anxious mature students had negative recollections, including the teacher being unsupportive, and not allowing questions in class. For low mathematics anxious students the teacher was also recalled as being intimidating and inaccessible, inflicting punishment, and focusing attention on the good students. Challenging teaching methods were not conducive to understanding mathematics. Among high mathematics anxious students the teacher was perceived as moving at a fast pace, being indifferent to the students’ understanding or success, and unaware of the students’ progress. The above factors were experienced by both low and high mathematics anxious students and reflect traditional teaching methodologies (Boaler, 2010; Haylock, 2018), inadequacies in the teachers’ instructional behaviour, including insensitivity towards the students (Allen, 2016; Boaler, 2010), instilling fear and dread (Ho et al., 2000), and a dislike of teaching mathematics themselves (Liu, 2016; Perry, 2004; Vukovic et al., 2013b). Incidents raised by mid-range students were the teacher’s inability to explain mathematics; the emphasis put on preparing for – particularly state – examinations, and the impact of a change of teacher, which altered the dynamic of the class negatively. Such experiences align with a
rigid teaching style not conducive to facilitating understanding or questioning (Allen, 2016; Boaler, 2010). For two older mid-range mathematics anxious students, the physical abuse inflicted on them by the teacher impacted severely on their subsequent engagement with mathematics. Indeed, these students’ recollections align with the effects of mathematics trauma (Allen, 2016).

The experiences of these mature students convey many negative impressions of the teacher teaching mathematics and engaging with the students, suggesting deficiencies in the teacher’s instructional behaviour (Geist, 2010; Jackson & Leffingwell, 1999), and teaching methodologies (Boaler, 2010; Finlayson, 2014; Geist & King, 2008), as well as the teacher’s own anxiety towards mathematics (Sloan, Daane & Giesen, 2003; Wood, 1988). The few positive incidents in respect of the teacher were conveyed by mid-range mathematics anxious students and painted a picture of the teacher being supportive and good at explaining, as well as facilitating understanding (Ganley & McGraw, 2016; Geist, 2010; Maloney & Beilock, 2012). However, only two students experienced these incidents, one of whom was educated in Ireland; this reflects the fact that experiences of secondary school mathematics teaching and learning have been negative for the majority of these students regardless of nationality.

Preparation of students for the transition to secondary school both at primary and secondary levels is important to ease that transition process (Boaler, 2010; Ní Shúilleabháin, 2014; Smyth, 2017). Awareness of the extent of students’ mathematics anxiety as they enter – and during – secondary school is central to ensuring teachers can address students’ concerns and difficulties with mathematics (Finlayson, 2014; Vukovic et al., 2013b). In addition, teachers’ own issues with mathematics need to be addressed through initial teacher education programmes, as well as through continuous professional development to ensure they present the right attitudes and use the most effective methodologies in the mathematics classroom (Liu, 2016; Perry, 2004; Sloan, Daane & Giesen, 2002). The provision of support measures for mathematics within the secondary school environment is important to ensure students feel they can deal with their problems with mathematics in a supported way (Allen, 2016; Boaler, 2010).

8.1.6 Past Experiences – Work Context

Mathematics is an essential skill for effective engagement in the workplace (DES, 2016; HEA, 2011; HEA, 2018; OECD, 2013). Many mature students have workplace
experiences that involve using mathematics in various ways (Selden & Selden, 2001) and at various levels (Grotlüschen, Mallows, Reder & Sabatini, 2016), and these experiences can be shared and built upon during their HE programme of study (HEA, 2011; Kelly, 2006). For the mature students in this study, there was awareness of the importance of mathematics in a work context; in most cases, mathematics was experienced and used at a basic level. For low mathematics anxious students the work context acted as a motivation and boost in confidence for further engagement with mathematics. There was an awareness that more complicated mathematical calculations were done by higher-ranking staff; and the need to do mental arithmetic at a fast pace contributed to increasing the confidence in doing mathematics subsequently. For mid-range students there was reference to the importance of getting the calculations right, and the need to get help from someone else. This led to a preference not to engage with mathematics or asking someone else to do it for them instead. For high mathematics anxious students being shown what to do was important in order to grasp the mathematics required for the job. One student has avoided all aspects of doing mathematics in a work context. It is evident among the high mathematics anxious students that past negative experiences with mathematics have impacted adversely upon all aspects of dealing with mathematics, even in the workplace. While the extent of mathematics usage depends on the workplace situation, it is evident that for many of these students the extent of the experiences of using mathematics in the workplace involved engagement with mathematics at a basic level, reflecting findings by Fitzsimons and Björklund Boistrup (2017) and Keogh, Maguire & O’Donoghue (2014). In addition, those students with high levels of MA needed greater support with mathematics in the workplace compared with the low mathematics anxious students. These findings also point to the need for induction initiatives in the workplace in order to reflect the extent of mathematics involved and the potential for advancement through training initiatives reflecting the role of mathematics.

8.1.7 Mathematics Achievement below Expectation

Past experiences of poor achievement lead to higher levels of mathematics anxiety, which in turn can adversely affect achievement (Cemen, 1987), resulting in students ultimately falling behind in mathematics and not being able to keep up with the progress of their peers (Ashcraft & Krause, 2007; Boaler, 2016; Maloney et al., 2013). For many of these mature students the impact of their negativity towards mathematics was the perception that they were not able to keep on top of the work and were falling behind, and unable to
catch up. In this regard, one common factor that featured across the levels of mathematics anxiety was a perceived lack of support from the teacher. In addition, for low mathematics anxious students being unable to approach the teacher resulted in an accumulated lack of understanding, and the time limitation for doing mathematics was ineffective. For mid-range students absenteeism due to illness meant being unable to catch up and led to disengagement with mathematics. Also, being unable to cope with higher level mathematics meant dropping to a lower level, which on some occasions was detrimental to future career options. For high mathematics anxious students contributing factors to falling behind included repeatedly not being able to work out problems successfully and not knowing if you are right or wrong; knowing you were in a lower level class and the impact on self-confidence; a perception that the teacher focussed on the better students, and that better teachers were kept for higher level classes; in addition, there was an awareness that during secondary school topics were getting more complex and this added to the challenges for some students. The recollections presented suggest that the students’ ability in mathematics was left unmonitored – or was not addressed – by the teacher, and they believed they were falling behind. Without the required support the students were unable to catch up, leading in some cases to the student dropping out of school prematurely, reflecting findings in the literature (Ashcraft & Krause, 2007; Boaler, 2016; Kearney, 2008; Maloney et al., 2013). Thus, the approachability of the teacher is crucial if a student experiences difficulty with mathematics, and by the same token, the teacher needs to be aware of the students’ ability and understanding of mathematics in order that they do not get lost in the syllabus and fall behind. This finding aligns with recommendations by Safford-Ramus (2018) which point to the need for teachers to engage with professional development opportunities to enhance their awareness of challenges posed by mathematics for students, and address their own inadequacies in respect of teaching mathematics.

8.1.8 Summary

The support of teachers and parents, as well as peers and – in later life – employers and work colleagues, is central to ensuring that engagement with mathematics in the school or work context is sustained and can prosper. Many of the environmental incidents presented above point to the significance of the teacher particularly in supporting students’ engagement with mathematics and facilitating their understanding of the subject during their school years. In addition, as the mathematics topics become more complex
students can get lost and can fall behind, fuelling their anxiety towards mathematics. Consequently, without the right support students’ experience of mathematics can potentially result in failure, disengagement and avoidance in respect of mathematics; in the workplace, a highly mathematics anxious individual can avoid situations involving using mathematics, potentially limiting career advancement.

### 8.2 Dispositional Antecedents

Since environmental antecedents impact on dispositional antecedents, some significant incidents have been touched upon in the previous section. The following section sheds light on dispositional factors which include self-doubt, preparation, the impact of failure, attitude to mathematics, and prior avoidance.

#### 8.2.1 Self-Doubt

Where students lack confidence in their mathematics ability or have lost interest in the subject, this can lead to self-doubt and impact negatively upon their working memory and approach to doing mathematics (Ashcraft & Moore, 2009; LeFevre et al., 2005, cited in Ashcraft & Moore, 2009; Zaslavsky, 1994). Experiences of feeling doubt in respect of their ability with mathematics were conveyed by these mature students for all levels of MA. For low mathematics anxious students the wording of examination questions can be challenging and cause them to question their ability. For one mid-range mathematics anxious student, her recollection of being told she was bad at mathematics had a long-lasting negative impact on her engagement with mathematics. For high mathematics anxious students there is evidence of doubt in their ability in mathematics; for students with a history of negative experiences with mathematics entering a mathematics classroom can be terrifying; sitting in a mathematics class can lead to strong negative feelings including discomfort and panic due to feeling lost; not wanting to ask questions in front of peers is driven by the fear of looking stupid or asking a stupid question; failure of a state examination impacted one student’s self-esteem considerably, leading her to believe that there are trick questions in the examination. For high mathematics anxious students their intention is to pass the examination, and they are content with the prospect of passing, as they believe they do not have the ability to be as good as their peers, thereby settling for achieving the minimum programme requirements, reflecting findings by Ashcraft and Krause (2007), Betz (1978), and Finlayson (2014).
8.2.2 Preparation

The students’ approach to preparation in mathematics can determine how they engage with and succeed in the subject (Chinn, 2017; Finlayson, 2014). For many of these mature students who engaged with the Irish school system their preparation for mathematics was largely dictated by a focus on the Leaving Certificate examination; this led to them being selective in their choice of topics and engaging in rote learning, leading to inappropriate study skills for engagement with mathematics in further and higher education, reflecting existing research by Gill & O’Donoghue (2006), Hourigan & O’Donoghue (2007), and O’Meara, Fitzmaurice and Johnson (2017). Consequently, these mature students’ past experiences of studying and preparing for mathematics was different to what they subsequently had to do in higher education.

All of the low mathematics anxious students prepared for mathematics in advance of starting at the HEI by attending the preparatory mathematics course offered by the HEI, which they found beneficial, and all but one engaged in self-study of mathematics as well. For these mature students preparation for their service mathematics modules involves plenty of effort and practice, as well as attending all classes and paying attention. This is supplemented by getting help from the lecturer and at the mathematics support centre on campus. This approach is instrumental in maintaining their confidence in and determination with mathematics, as is keeping up with the workload. For mid-range mathematics anxious students effort and support are also important. Being able to see the relevance of mathematics is central to them grasping the topics. Using simple English to interpret a problem is useful, as is being able to visualise a problem; however, this is more difficult with abstract concepts like algebra. Some students resort to cramming or memorising content before an examination due to lack of understanding and lack of confidence. For high mathematics anxious students there is a tendency to learn off content without understanding what it is about; these students do not engage with the mathematics support centres; one student believes he is unable to learn mathematics as a result of the long-term impact of not engaging and not being successful with the subject. Most of these students have learned to cope with what they perceive as a difficult subject by being strategic in their approach to doing assessments and examinations, and with an emphasis on wanting to pass the module.

While the low mathematics anxious students are confident, aware, have greater understanding of what the mathematics means to their programme of study, and are
proactive about what is required to succeed in mathematics, the mid-range mathematics anxious students try to understand the mathematics and see its relevance, but this does not always happen, and they will seek help. Further, the high mathematics anxious students try to get by themselves by being strategic about getting enough marks to pass. That is all they want to achieve, and in this regard their approach to preparation is strategic, with minimal effort or support from others.

The issues arising from the above findings have implications for secondary school mathematics education as well as mathematics at higher education; research shows that the better prepared students are when leaving secondary school, including having done higher level mathematics, the better they will be able to transition to doing service mathematics in higher education (Hourigan & O’Donoghue, 2007; O’Meara et al., 2017). This efficiency in preparation by the end of senior cycle must start much further back in the student’s schooling in order that appropriate study skills are practised and built upon as the student progresses through secondary school. Study skills in mathematics may have to be taught. With mature students, they have been out of education for a number of years and approaches to teaching and learning mathematics may have changed in the intervening years. Consequently, higher education institutions must accept that there is likely going to be a disparity in mature students’ preparation and study skills, which will necessitate compulsory preparatory instruction in advance of the mature student starting their programme of study at the HEI; this finding substantiates research by Johnson and O’Keeffe (2016).

8.2.3 The Impact of Failure

Failure in mathematics – and especially repeated failure – contributes significantly to the belief of the importance of having to get the right answer (Frenzel et al., 2007; Marshall et al., 2016), and in this regard adds to the student’s dislike of mathematics and subsequent engagement with mathematics (Cemen, 1987; Miller & Mitchell, 1994; Vukovic et al., 2013a), sometimes leading to the student avoiding mathematics as much as possible (Ashcraft & Krause, 2007; Chinn, 2017). All of these mature students had experienced failure in a previous mathematics examination; however, the experience had different follow-on outcomes; for low mathematics anxious students failure in mathematics was the impetus to do better the next time, and therefore acted as a motivator (Duckworth et al., 2007; Dweck, 2017). For two mid-range mathematics anxious students
failure resulted in punishment which added to their fear around mathematics. Despite their mid-range scores these students expressed fear of mathematics in their interviews and a preference not to engage with mathematics beyond what they needed to in HE. For high mathematics anxious students fear of failure has driven these students to cope with what they see as a difficult subject. Their aim has since been to pass mathematics, even if they do not understand it. For these students fear of failure has driven them to engage with rote learning as a result of ‘mislearning’ (Illeris, 2007) and a belief that they cannot understand mathematics, therefore doing what is required to pass service mathematics. One student expressed a helplessness around mathematics (Marshall et al., 2016) that led to him apportioning blame to his teachers, which contradicts findings by Cemen, (1987) that high mathematics anxious students apportion blame internally, that is to themselves, rather than externally to the teachers.

8.2.4 Attitude to Mathematics

Attitudes to mathematics form over time as a result of often repeated emotional responses to situations involving engagement with mathematics (Evans, 2000; McLeod, 1992; Zan et al., 2006). Cemen (1987) presents attitude to mathematics in the context of its usefulness and the perception of mathematics as a male domain. Findings in respect of attitude towards mathematics were conveyed mainly in terms of the perceived usefulness and relevance of the subject, with no student making reference to mathematics as a male domain. All of these mature students believe mathematics is an important subject, but they differ in terms of how they see its relevance as an academic subject and in everyday life.

While the attitudes towards mathematics among the low mathematics anxious students are largely positive, these students have overcome adversity in their engagement with mathematics during school years. This has been expressed by a change in attitude over time and impacted upon by being exposed to the relevance of mathematics through life experience in the workplace, the ability to deal with and move on from failure in mathematics examinations, seeking support and putting in effort to overcome a shortfall in understanding of mathematics concepts. They have shown that – particularly negative – attitudes to mathematics can change. The importance of mathematics motivates them to be competent; although one student did not see the relevance of a statistics module in his engineering programme (Dweck, 2017; Selden, 2005).
There is a variation in attitudes among mid-range mathematics anxious students, with an appreciation of the relevance of mathematics to work contexts, but an awareness that not being able to understand can be detrimental to work advancement. In addition, abstract concepts are seen as difficult to apply to real world contexts. Among the high mathematics anxious students mathematics constitutes the academic subject they encounter in school or at the HEI and is perceived as different from using numbers every day or in a work context; that belief combined with a deficit in understanding and uncertainty about the relevance of mathematics – particularly abstract concepts (Ashcraft & Moore, 2009; Haylock, 2018) – contributes to their distancing from the subject and higher levels of anxiety towards mathematics (Cuben, 2000; Thumpston & Cuben, 1994). For one high mathematics anxious student her decision to defer her programme was due largely to the mathematics content. This example demonstrates the potential global impact of MA (Ashcraft & Krause, 2007; Wilder, 2013). There is a tendency among mid-range and high mathematics anxious students to compare themselves negatively with traditional students in terms of the gap in knowledge attributable to the many years they have been out of school, thereby upholding findings by Gill and O’Donoghue (2006) and Golding and O’Donoghue (2006).

Having heard these students’ stories has allowed the researcher to have an overall picture of the development of and changes in attitudes over their life engagement with mathematics. In some cases negative attitudes towards past experiences of mathematics have changed to more positive ones for low mathematics anxious students; for some mid-range students past negative attitudes have been turned around as a result of the difference in teaching methods in HE – compared to what they were used to in second level – as well as the availability of support for mathematics. The desire to succeed in their programme of study has been the impetus to do well at mathematics for many students, especially those with higher levels of mathematics anxiety, some of whom do not want to engage with mathematics after HE.

8.2.5 Prior Avoidance

The existence of mathematics anxiety can lead to students avoiding mathematics as a coping mechanism (Cemen, 1987; Fletcher & Cassady, 2010). Students who avoid engaging with mathematics do so in response to their past experiences of mathematics; consequently, they withdraw effort from learning mathematics in order that the negative
experiences will not be repeated (Boaler, 2016; Fletcher & Cassady, 2010; Turner et al., 2002). Among the mature students in this study, it is noteworthy that the topic of avoidance did not feature among the low mathematics anxious students. For some mid-range mathematics anxious students a history of avoidance of mathematics prompted them to opt for a programme of study that seemed unrelated to mathematics. However, the study of many disciplines includes exposure to mathematics, even though that may not be evident from the programme or module titles. For some high mathematics anxious students the impact of prior avoidance of mathematics was far-reaching, resulting in students being strategic in their attempts to succeed with mathematics, as well as one student deferring her programme of study. In this regard and in line with findings by Boaler (2016), Fletcher and Cassady (2010), Turner and colleagues (2002), and Maloney and Beilock (2012), it is important that such attitudes towards mathematics leading to avoidance are detected as early as possible in the learner’s experiences with mathematics in order that they can be addressed and counteracted.

8.2.6 Summary

The impact of environmental antecedents is evident in how the student’s disposition towards mathematics evolves, with past experiences contributing to the student’s level of preparation, attitude and tendency to engage with mathematics. Being well prepared and availing of support contributes to confidence with mathematics, thereby reducing self-doubt. However, a student’s confidence with mathematics can also be impacted upon by others, with negativity towards the student’s efforts impacting adversely on their engagement with mathematics. For mature students, being out of education for a number of years or longer can also have a bearing on their self-confidence with mathematics, thereby distinguishing them from their traditional counterparts. Their attitudes towards mathematics are influenced by their beliefs about the subject, and these may take time to change. The experience of failure in mathematics can be devastating to subsequent progress with mathematics, sometimes leading to avoidance of mathematics, and in this regard, adequate support is required to ensure the student can move on from that experience.
8.3 Situational Antecedents

Situational factors relate to more current factors and together with dispositional antecedents, bring on anxiety if the situation involving engagement with mathematics is perceived as stressful or threatening to the student’s self-esteem. These situational antecedents include the nature of mathematics, classroom factors, the way mathematics is taught, and the test situation.

8.3.1 The Nature of Mathematics

All of these students had at least one service mathematics module in their programme of study, while some students had multiple modules. The presence of a service mathematics module within a HE programme of study may come as a surprise to some students (Fitzmaurice et al., 2015), and in this study a total of four of the twenty mature students (20%) did not know before they started at the HEI that there was a mathematics module in their programme of study, three of whom were mid-range and one high mathematics anxious. Two additional mid-range students admitted they did not know there would be so many mathematics modules due to the different naming conventions used (Fitzmaurice et al., 2015). The downside of this was the considerable amount of study time required at the expense of other subjects. One mid-range mathematics anxious student questioned the need to do mathematics if software programs can do so much of the tasks required for engineering. This may point to a shortfall in the presentation of the mathematics content without consideration of the application of mathematics to the use of software technologies.

Among low mathematics anxious students, incidents with mathematics as a subject were not highlighted, except where two students at the higher end of this cluster perceived a difference between the way they used academic mathematics and everyday mathematics. This distinction is more typical among students with higher levels of mathematics anxiety (Buxton, 1991; Coben & Thumpston, 1995) and in this regard is unusual for students with low levels of mathematics anxiety.

Many mid-range mathematics anxious students convey a sense that the content of their service mathematics modules emphasises rules, with an emphasis on getting the answer, and thereby corroborate research by Tobias (1993), Boaler (2016), and Chinn (2017); in this way, the students observe that the nature of service mathematics is different from other subjects where you can argue a point. Also, where mathematics is presented without
a context poses a problem for understanding the topics and being able to apply them to everyday situations, again reflecting research by Boaler (2016) and Chinn (2017). The presentation of mathematics without a suitable context likens the mathematics to a set of rules and procedures without meaning and represents a missed opportunity on the part of the lecturer to engage the students at a deeper level. In this regard, an insight into the history of the mathematics concepts is beneficial, as endorsed by Mac an Bháird (2011).

There is a perception among some mid-range and high mathematics anxious students that traditional students have superior mathematics knowledge to mature students, due to the time the latter have been out of formal education, which corroborates research by Breen, Prendergast and Carr (2015). However, this perception may also be as a result of self-esteem issues accompanying the transition to higher education and all that it entails for the mature student as conveyed by Safford-Ramus (2008) and Cilasun and colleagues (2018); further, this may also be due to an awareness that the HE system facilitates the needs of traditional students more so than those of mature students, as conveyed by Kelly (2006). In this regard, it is essential that HEIs – especially in the climate of widening access – are more inclusive of the variety of students that enrol and take dedicated and appropriate measures to address the needs and concerns of mature students.

Both mid-range and high mathematics anxious students rely on online resources such as YouTube and Khan Academy to help with understanding mathematics. Further, while most mid-range mathematics anxious students avail of help in the mathematics support centre at the HEI, the high mathematics anxious students do not attend mathematics support centres and prefer private one-to-one tuition. For high mathematics anxious students there is difficulty practising questions by oneself, as it is difficult to know if the question is answered right, and if they are using a calculator right. In this regard, reassurance from someone else – preferably a lecturer or tutor – is important (Pritchard & Roberts, 2006). Reading textbooks can be problematic for some students, and they may resort to online resources such as YouTube and Khan Academy. It is evident from these findings that mature students will seek additional support for mathematics, using varied resources. However, choosing the right online resource, particularly on YouTube requires that the user be aware of what is a legitimate resource (Zengin, 2017); in this regard, it would be beneficial if the service mathematics lecturer – or module team comprising lecturer and tutor(s) – were to compile their own online video resources to complement the lectures and to counteract the inadequacies of non-legitimate resources. In addition,
advice in respect of legitimate sources of mathematics support – both within and external to the HEI – needs to be provided by mathematics departments in HEIs, thereby acknowledging research by Faulkner, Fitzmaurice and Hannigan (2016), Thompson (2011), and Zengin (2017). Further, the concept of the flipped classroom (Bergmann & Sams, 2012) is a worthy consideration for the delivery of service mathematics.

While techniques like visualisation and mnemonics can help some students understand mathematics, it is difficult with abstract concepts, such as algebra which is seen as mysterious and non-sensical. This contention is a likely contributor to the higher levels of anxiety asserted by these students, thereby reflecting findings by Boaler (2016) and Chinn (2017). Thus, for students with higher levels of mathematics anxiety the topics – particularly abstract concepts – need to make sense, and timely reassurance of the students’ progress with mathematics is essential in building confidence with mathematics. Further, since students are first introduced to abstract concepts, including algebra, formally at primary school and informally in early childhood educational settings or preschool (NCCA, 2016), there needs to be more awareness among primary school teachers of the possible difficulties abstract concepts can pose for learners. In addition, as students progress from primary to secondary school the challenges posed by more advanced abstract mathematics concepts may increase if they are not dealt with effectively at primary level to ensure a smooth transition (Ball, Thames & Phelps, 2008; O’Meara et al., 2017). In addition, the second level mathematics teacher, particularly in first year, must be equipped to support students in overcoming these challenges thereby facilitating curriculum and pedagogical continuity (O’Meara et al., 2017; Tilleczek, 2008).

8.3.2 Classroom Factors

The mathematics classroom environment is impacted upon by the teacher’s personality and the nature of the class itself; in this regard a teacher’s negative disposition towards mathematics, as well as a large class size, time limitations and a lack of individual support can represent stressors for students that are conducive to the onset of mathematics anxiety (Cemen, 1987). If the teacher conveys a positive attitude and facilitates an atmosphere where students can feel comfortable with mathematics the students’ self-esteem is less likely to be threatened (Cemen, 1987; Gunderson et al., 2012; Maloney & Beilock, 2012). Among this cohort of mature students, there is a desire to have the opportunity to talk with the service mathematics lecturer or tutor particularly after class; this is important to
those mature students who seek assistance or reassurance with mathematics and reflects findings by Boston (2017), and Kaldi and Griffiths (2013) in respect of the value mature students place on positive contact with staff at the HEI. However, the opportunity is not usually afforded to them.

This study found that mature students with low MA are proactive about engaging with their lecturers and asking for help with mathematics where needed. In addition, some mid-range mathematics anxious students commented that lecturers give notes to supplement the mathematics lectures and this is helpful to facilitate understanding of topics. However, not all lecturers are available to students at the end of lectures and this is regrettable, as it is not feasible for the students to interrupt the lecture to ask questions. One student commented that a lack of enthusiasm on the part of the lecturer was demotivating. High mathematics anxious students also experienced the lecturer giving notes to supplement classes. However, where concepts were not clear, some students expressed a reluctance to ask questions in class for fear of disapproval among classmates; they remarked that it would be desirable to ask the lecturer questions after class, but they either do not remain or they tend to give just the answer when a more detailed explanation is what is required. Despite having email contact details for lecturers some students prefer the personal contact in respect of knowing they are doing mathematics the right way. Reassurance is significant here. Thus, while these students’ experience of the mathematics lecturing staff is largely positive, these mature students do not always get clarification of concepts within lectures and tutorials, and consequently would like to continue the discussion of the mathematics topics directly or soon after class has finished. It is evident from these findings that lecturing staff are helpful and have positive dispositions towards the service mathematics they teach; however, the mature student needs to get clarification on aspects of what they are learning and, in this regard, rely on the lecturer for support. Thus, the lecturer’s scheduling of some time conducive to being available to talk to mature students would help alleviate some of the issues that contribute to the students’ accumulation of negative attitudes towards service mathematics (Pritchard & Roberts, 2006).

With respect to the nature of the class itself, low mathematics anxious students feel that the lecture itself – due to its size and/or the public setting – is not conducive to asking questions. Some lectures are too long, and this has a negative impact on students’ concentration. For mid-range mathematics anxious students the pace and size of some lectures, as well as the volume of material to get through are also identified as challenging.
While tutorials are conducive to learning due to their small size and the attention given to the students by the lecturers/tutors, as well as the ability to ask questions, however, due to timetabling constraints, tutorials are not always possible to attend. In addition, lecturers/tutors may only have a small amount of time to spend with each student. There is time pressure on the student here, and that can add to the anxiety, because the problem will not get resolved if there is a time limit. In addition, there is a perception that there is miscommunication between what goes on in the lecture and the tutorial. For high mathematics anxious students not having sufficient time to do mathematics problems can be a challenge. This points to a need for proactive communication between lecturers and mature students to contribute to a positive experience of the subject and programme, thereby upholding findings by Luk (2005) and Selden (2005).

Many of these mature students experienced large lectures, with much content and a fast pace, and a context not conducive to getting clarification on what is not understood. If tutorials are not available to students due to timetabling clashes, these students miss out on important opportunities to revisit the mathematics content in a less intimidating classroom context. While large lecture sizes and increased volumes of material are synonymous with the HE learning environment, advance preparation for these eventualities would benefit the mature student, and in this regard, preparatory or induction courses, as well as ongoing support in the HEI for mature students have a role to play in helping to improve grades as well as student retention (Johnson & O’Keeffe, 2016; Moses, Hall, Wuensch, De Urquidi, Kauffmann, Swart, Duncan & Dixon, 2011).

8.3.3 The Way Mathematics is Taught

The way mathematics is taught hinges on the effectiveness of the teaching methods employed and the instruction style of the lecturer (Bartlett, 1995; Kyle & Kahn, 2009). In addition to the formal lectures and tutorials, mature students proactively avail of additional support in mathematics, including talking to their lecturers, attending dedicated mathematics support centres, engaging in peer support, and private tuition (Boston, 2017; Breen et al., 2015; Kyle & Kahn, 2009; Lawson et al., 2003). The findings of this study depict that regular support from a number of sources is very important for all of these students, irrespective of their level of mathematics anxiety, thereby endorsing findings by Pritchard and Roberts (2006); however, the type of support availed of varies among these students.
For these mature students despite different levels of mathematics anxiety, the fast pace of lectures has been an issue, as it was not conducive to grasping what was going on with the mathematics presented. Many felt that more time was needed to understand, as well as the need to repeat what was just presented. Further, the service mathematics teaching methods experienced by these students in their respective HEIs largely reflect the use of rules, formulae and procedures, with differing accounts of the presentation of context; however, the desire of low mathematics anxious students to understand the mathematics content has resulted in them having a greater appreciation for the service mathematics they do in the context of their chosen discipline of study. In contrast, for mid-range and high mathematics anxious students there are challenges with the lecturer’s methods in terms of what is written on the board, grasping the relevance of the topics, and dealing with a considerable volume of material in lectures. High mathematics anxious students mentioned getting lost in lectures, with the risk of the uncertainties accumulating, and a tendency for these students to rote learn at the expense of understanding, and doing the minimum required to pass their examinations. Having different lecturers on the same module can add to the challenges of the high mathematics anxious student if they each use different approaches. It is evident that the teaching methods of the lecturer play a significant role in how effectively the students grasp the concepts as they are being presented in lectures. Lecturers need to ensure they are aware of students being lost or left behind, and in this regard allowing time to go through concepts again in detail is necessary in order to engage these students at risk of falling behind. Also, as outlined in the previous section, the lecturer being accessible to students after lectures is essential in order that mature students have the opportunity to talk to the lecturer and express their difficulties with the subject.

All of these mature students who have attended the mathematics support centre at their HEIs commend the approach of the staff, in particular with their slower pace, empathy for the mature student, and simplification of the mathematics topics. While low mathematics anxious students have a propensity to be better prepared for their engagement with mathematics and will actively avail of support with mathematics as part of their preparation routine, students with mid-range and high levels of mathematics anxiety show inconsistencies in their awareness of and engagement with mathematics support facilities. For students with mid-range and high levels of mathematics anxiety who have engaged with efforts to prepare for mathematics they have more positive
dispositions about engaging with mathematics in class. Some students avail of peer support and find it mutually beneficial to talk about the mathematics. However, some mid-range mathematics anxious students were not aware of the mathematics support facility at their HEIs, with a majority of IoT2 students and one Uni1 student being unaware; one high mathematics anxious student did not know about the mathematics support at her HEI (IoT2), she deferred her place, and has employed a private tutor to help her with mathematics. This lack of awareness of mathematics support among students is concerning and poses the question about the extent of publicity of mathematics support at these HEIs. In addition, the other high mathematics anxious students tried to attend the mathematics support centre at their respective HEIs, but issues ranging from limited opening hours, the centre being too busy, and timetable clashes to not knowing what to ask and fear of looking stupid prevented these – most in need of help – students from engaging with this crucial service. Thus, while the service provided through the mathematics support centres at the HEIs is very positively received among most students, certain issues need to be addressed to ensure all mature students – particularly those with higher levels of mathematics anxiety – can avail of its services; these could include extended timetabling or opening hours for the service, ease of access, including correspondence using an online platform, and ensuring potential attendees are not put off by seemingly busy sessions at the mathematics learning centres. Also, the identification of high mathematics anxious mature students early in the course of the programme so they could avail of appropriate supports would be beneficial all round.

8.3.4 Test Situation

Situations of testing and evaluation in mathematics can give rise to considerable anxiety, not only during the test itself but with the anticipation of being examined in mathematics (Hembree, 1990; Young et al., 2012). The outcome can have a detrimental impact on performance in mathematics, which in turn adds to the anxiety felt in advance of subsequent examinations (Reyes, 1984; Zan et al., 2006). The better prepared and more engaged a student is with mathematics the lower their level of anxiety in advance of and during test situations (Chinn, 2017; Turner et al., 2007; Zeidner & Matthews, 2011).

In this study, all students admit being anxious in respect of mathematics examinations and have their own strategies for dealing with the prospect of examinations, but these vary considerably depending on the level of anxiety expressed; low mathematics anxious
mature students admitted that while dealing with examinations can be challenging, being well prepared to approach the examinations is important to them. For mid-range mathematics anxious students there are different approaches to preparing for the examinations, including learning off material, or being selective in learning what will allow you to pass the module. For high mathematics anxious students the mode of examination may not be conducive to enabling the learning of mathematics, for example online quizzes require the answer, rather than encouraging the student to engage with the method.

However, all of these students admit that unforeseen challenges can emerge during the examination; many students with both low and mid-range mathematics anxiety experienced not being able to move beyond a certain point in solving a mathematics problem which caused anxiety and panic in the mathematics examination. Some students questioned if there were trick questions in an examination, as the questions seemed so different to what was done in lectures. For high mathematics anxious students not knowing the correct approach in an examination can lead to frustration, anxiety and panic.

Students at all levels of mathematics anxiety agreed that having a continuous assessment component in a module is beneficial, as they can see progress during the term, and know how they fare in mathematics before the terminal examination. For students whose first language is not English, the wording of some questions can be problematic. Where a student has a learning difficulty like dyslexia, it adds extra pressure to an already stressful situation, as referred to by Ansari (2013) and Mazzocco (2007); in this regard one high mathematics anxious student has learned to cope and take his time doing questions.

In advance of the mathematics examination it is important that students are well informed about the examination, in order that they could prepare adequately and that there would be no surprises, thereby lessening their anxiety. Despite feeling anxious about their examinations, low mathematics anxious students are relatively better prepared than students with higher levels of mathematics anxiety. In this regard, more anxious students would benefit from additional support with examination study skills and preparation tips, as suggested by Chinn (2017) and Zaslavsky (1994). In particular, students with learning disabilities such as dyslexia or dyscalculia need additional assistance in learning mathematics, and in this regard, early detection of the learning disability is essential in
order that the student has access to adequate resources, thereby reflecting findings by Ansari (2013) and Mazzocco (2007).

Students at all levels of mathematics anxiety can get stuck with a mathematics question during an examination and this can lead to pressure and panic, which may cause the student not to finish the examination. In such situations the student is completely on their own with no evident way around the obstacle they encounter. Being able to ask for help or have a break in such situations – as advocated by Zeidner and Matthews (2011) – could alleviate this pressure and potentially avoid situations of panic. In addition, it is likely that the learning outcomes of the service mathematics modules could be realised using different assessment types; in this regard the lecturer or module team needs to revisit the learning outcomes and review alternative methods of assessment where possible.

8.3.5 Summary

The extent of anxiety induced as a result of these situational antecedents is dependent on the student’s disposition towards mathematics. The presence of mathematics in a programme of study may not have been anticipated by the prospective mature student, and therefore pose an additional challenge for them in the HE environment. The nature of the mathematics encountered in lectures can represent a significant departure from the mathematics experienced by the mature student some years previously and may pose a threat to their self-esteem and confidence with mathematics. Mature students will avail of support with mathematics, and knowing that such support is available is important to their engagement with the subject. The lecture itself can be a daunting experience for the student, and the personality and approachability of the lecturer, as well as the teaching methods used, can make a difference in how the student connects with mathematics. Mature students need to be able to ask questions soon after they have experienced a problem with lecture material, and support from the lecturer in this regard is significant. Mathematics support facilities represent a worthy resource for mature students and their services need to be well publicised. Since test situations lend themselves to the most anxiety experienced among students, the mode of examination of mathematics modules should reflect the learning styles, and demographics of students, in order that the assessment of the learning outcomes accommodates a more heterogeneous cohort of students.
8.4 Conclusion

This chapter presented an interpretation of the findings of this research study as framed by Cemen’s (1987) Model of a Mathematics Anxiety Reaction. The discussion around environmental antecedents has revealed that past experiences of mathematics at school have had a significant impact on students in respect of how they feel about mathematics currently, and thereby contributing to their dispositional antecedents; in particular, negative experiences characterised by struggling to understand mathematics topics, and without support from the teacher or a parent, have caused those mature students with higher levels of mathematics anxiety to have difficulties with mathematics throughout their schooling and in higher education. In respect of the situational antecedents, there are many factors for the mature student studying service mathematics in HE to take into account, including the challenges of the learning environment, their approach to preparation for mathematics and propensity to avail of support for mathematics, as well as the extent of their commitment to the examination process. This discussion has provided much evidence to endorse and uphold existing research, as well as prompt considerations for relevant stakeholders, and recommendations for further research. These matters will be addressed in the next and final chapter.
Chapter 9 Conclusion
9.0 Introduction
This final chapter revisits the research aim and questions and examines how these are addressed within the context of this study. The contribution of this work for institutional, national, and international stakeholders is communicated throughout the chapter, as well as implications and recommendations arising from this study. Strengths and limitations are identified, and suggestions for further research are presented.

9.1 Thesis Summary
The purpose of this study was to better understand the extent of mathematics anxiety among mature students who study service mathematics in Ireland, and thereby identify the significant incidents in their lives that have led to the way they feel about mathematics, particularly negative feelings that give rise to the levels of mathematics anxiety they have declared. The study evolved from the researcher’s interest in obtaining an insight into the extent of mathematics anxiety among mature students and the possible causes of their levels of mathematics anxiety. Thus, the research aim was to investigate the existence and derivation of mathematics anxiety among mature students studying service mathematics in Ireland. Two research questions (RQs) were derived to assist in achieving the research aim:

1. To what extent does mathematics anxiety exist among mature students studying service mathematics in Ireland?
2. To what extent do specific incidents in a mature student's mathematics life story give rise to the level of mathematics anxiety that the student experiences/identifies with?

In order to address RQ1, the extent of mathematics anxiety among mature students was explored through the survey with emphasis on the results of the Mathematics Anxiety Scale – UK (MAS-UK). Results pertaining to RQ1 portray the mature students in this cohort as reflective of the wider profile of mature students in Ireland as presented in the literature review. The results revealed that mathematics anxiety as measured by the MAS-UK does exist among these mature students, although the distribution of scores showed a large concentration of scores depicting low to moderate levels of mathematics anxiety. None of these mature students scored very high on the scale, which seemed to contradict some of the anecdotal evidence shared over time with the researcher and prompted the researcher to look closer at the three factors and individual statements of the MAS-UK. Consequently, much detail on the mature students’ levels of mathematics anxiety has
emerged through the analysis of their scores for each of the factors. Further investigation revealed a higher range of mathematics evaluation anxiety among these mature students. In contrast, everyday/social mathematics anxiety and mathematics observation anxiety levels were relatively low among the cohort. This outcome verified that the most likely cause of higher levels of mathematics anxiety among these mature students is the prospect of being evaluated or tested in mathematics, as well as having to do mathematics problems in front of others, including the teacher. In addition, the prospect of using mathematics in everyday or social situations or being in situations where the mature student is observing mathematics being done by someone else results in lower levels of mathematics anxiety among this cohort.

The approach to eliciting the results for RQ2 necessitated the integration of two data sets: the MAS-UK scores from the questionnaires and the corresponding interview data for the twenty mature students who opted into the interview process. The MAS-UK scores provided a method of differentiating the mature students’ interview responses according to low, mid-range and high levels of mathematics anxiety. In this way the interview responses could be utilised to shed greater light on the experiences of those students who had low, mid-range, or high levels of mathematics anxiety. The responses were initially categorised into the three MAS-UK factors: mathematics evaluation anxiety, everyday/social mathematics anxiety and mathematics observation anxiety. Subsequently, the results for each level – low, mid-range, and high anxiety – were presented following the sets of antecedents from Cemen’s (1987) Model of a Mathematics Anxiety Reaction in order to group the responses. This provided a methodical approach to eliciting those significant incidents that contributed to the level of anxiety expressed by the mature students, and in particular, it allowed for the nature of the experiences to be more clearly identified as pertaining to situations of mathematics evaluation anxiety, everyday/social mathematics anxiety or mathematics observation anxiety.

The findings for RQ2 depict that there are many significant incidents that give rise to mathematics anxiety among these mature students; these incidents can be environmental, occurring largely in the past, but having an impact on the student’s disposition towards mathematics, and situational, with a more recent context. Some common incidents were experienced by mature students with varying levels of mathematics anxiety. In particular, negative experiences of doing mathematics in primary school were dominated by the fear associated with the public context of doing mathematics – often standing up – in front of
others, including the teacher and classmates. In secondary school the lack of teacher and parental support felt by students in helping them to do and grasp mathematics was significant in leading them to fall behind. In this regard, the mathematics teacher at second level was recalled by many students with much negativity. Parents featured prominently in respect of only being able to help with mathematics to a certain level – typically to the end of primary school, with the mother being more active in this regard.

Mature students with low levels of mathematics anxiety have been proactive about preparing for mathematics, as well as attendance at all classes and using the mathematics support facility. In contrast mature students with high levels of mathematics anxiety have trouble grasping concepts and do not tend to engage with the HEI’s mathematics support facility; they exhibit avoidance tendencies in their engagement with mathematics, and their impetus is to get enough marks to pass the examination, so they frequently resort to rote learning of mathematics concepts. The most popular strategy with mathematics among mature students with low and mid-range mathematics anxiety is to try to understand the mathematics topics, followed by a focus on getting the right answer and passing examinations. While all of these mature students expressed awareness that mathematics is an important subject, some including those with mid-range and high levels of mathematics anxiety would prefer not to engage with it after HE; in contrast, those with low levels of mathematics anxiety see mathematics as very important to their future careers and are aware of the relevance of their service mathematics topics to their discipline of study.

9.2 Implications and Recommendations

International evidence shows that mathematics anxiety exists across the education spectrum as well as in every day engagement with situations involving mathematics use outside of academia (Buckley et al., 2016; Dowker et al., 2016; Pampaka et al., 2018). The findings of this study verify the existence of varying levels of mathematics anxiety among a cohort of mature students attending HE in Ireland and substantiate findings from other jurisdictions in respect of the existence of mathematics anxiety among adult learners in higher education at undergraduate level (Hunt et al., 2011). Thus, the implications of the study have significance for the teaching and learning of mathematics at all levels of the education system, thereby having relevance at institutional, national and international levels. The findings have drawn together a number of implications for the teaching and
learning of mathematics; these reflect the impact of significant incidents that have contributed to the levels of mathematics anxiety among these students, stemming from different stages of their education and overall engagement with mathematics. The presentation of implications, which is complemented by relevant recommendations for each point, makes reference to the stages of education – primary, secondary, and higher education –, significant individuals, the workplace, as well as mathematics support, assessment methods, and the mature student.

9.2.1 Mathematics at Primary Level – the Role of the Teacher

The findings of this research have shown that scenarios involving being evaluated or tested in mathematics and being asked by the teacher to solve mathematics problems in front of others resulted in raised levels of mathematics anxiety. These unpleasant feelings exist today for many of these mature students, but they stem from experiences of learning mathematics in primary school where being put on the spot – frequently standing up – to answer a question quickly was the preferred method of verifying the child’s ability in mathematics. The findings show that these incidents still have an impact many years or even decades after leaving primary school and point to the pivotal role of the teacher in primary school. Consequently, it is important that primary school teachers do not single out a child to do a mathematics problem, particularly under pressure of time, as well as making the child stand up in class, and where it is known that the child is struggling with mathematics.

Awareness of the child’s ability and progress in mathematics is important in this regard, and alternative problem-solving techniques can help to alleviate the potential impact of mathematics anxiety (Ramirez et al., 2013). Where students have a learning disability, like dyslexia or dyscalculia, detection of this at an early stage is essential in counteracting the effects of dyslexia or dyscalculia that can lead to the development of mathematics anxiety (Ansari, 2013; Mazzocco, 2007). Monitoring levels of anxiety with a suitable measurement scale, like the child math anxiety questionnaire (CMAQ) for early primary school years (Ramirez et al., 2013) and the modified Adolescent Mathematics Anxiety Scale (mAMAS) for older primary school children (Carey et al., 2017), can help teachers to detect mathematics anxiety from an early stage and continuing through primary school, thereby allowing for the development of suitable techniques to help children overcome their fears in respect of mathematics.
Awareness of and resourcefulness by the teacher in respect of the difficulties posed by abstract concepts can help to counteract the onset of negative feelings towards such topics (Boaler, 2016; Chinn, 2017), thereby setting a positive attitude towards the abstract concepts the children will encounter throughout their mathematics education in primary and secondary school. In addition, as students prepare to progress from primary to secondary school the role of the sixth class teacher is pivotal in preparing the child for an effective transition to mathematics at secondary school, and efforts to improve mathematics knowledge for both sixth class teachers and first year mathematics teachers in secondary school are necessary to ensure a smooth transition for all students, thereby corroborating findings by O’Meara and colleagues (2017).

However, the effectiveness of these measures hinges on the level of mathematics anxiety of the primary school teacher (Beilock et al., 2010), and any difficulty the teacher has in this regard needs to be dealt with through identification and acknowledgement of their anxiety towards mathematics and participation in appropriate professional development initiatives (Dowker et al., 2016; Lyons & Beilock, 2012; Maloney et al., 2014). In addition, similar measures need to be included in initial teacher education programmes (LoPresto & Drake, 2004), in order that any potential difficulties with mathematics can be addressed before graduation and subsequent employment.

### 9.2.2 Mathematics at Secondary School

The findings of this study have shown that secondary school is a significant time in a student’s life where they can become lost with mathematics, resulting in uncertainty regarding what they are doing, leading to considerable levels of mathematics anxiety. It can be difficult to keep up; they are exposed to new more abstract concepts, often without a context; there are time limitations within the class period that are not conducive to asking questions or delaying the teacher; and sometimes subsequent mathematics classes can be scheduled days apart, so the momentum for asking questions to enable understanding is lost during this time. The students may not want to ask the teacher for help and their parents may not have sufficient knowledge of the mathematics content to help; however, the students do need support with mathematics, and the availability of suitable resources and supports in mathematics is central to ensuring that students do not fall behind. Following on from primary school, students’ levels of mathematics anxiety at second level must continue to be monitored; in this regard, the mAMAS (Carey et al.,
is also suitable for use with second level students, as is Chui and Henry’s (1990) Mathematics Anxiety Scale for Children (MASC). In this way, appropriate measures can be adopted to identify the circumstances that give rise to anxiety towards mathematics, thereby counteracting the impact of mathematics anxiety.

These findings show that in these students’ experiences of the Junior Cycle, mathematics represented a considerable departure from the mathematics experienced at primary school, particularly regarding a lack of context for topics, and suggesting a difficult transition from primary school. In Senior Cycle, there was considerable emphasis on the Leaving Certificate examination and dependence on it as a gatekeeper subject to go further in work or education circles. Mature students with low and mid-range levels of mathematics anxiety mentioned the challenges of higher level mathematics for the Leaving Certificate, but there was a lack of encouragement by the teacher for students who might have had to work harder at higher level mathematics, while the decision by the student to move to the ordinary level mathematics class was generally not refuted by the teacher. Thus, this was experienced as a lack of support from the teacher, in favour of keeping the best students in the higher level mathematics class. High mathematics anxious mature students in particular made reference to teachers wanting to teach ‘the good kids,’ and the awareness that one was of a lower ability within the class led to negative feelings about their self-concept in mathematics. Some availed of private tuition for higher level mathematics, but this was not accessible to all due to the cost factor.

While the findings endorse the importance of effort and preparation for success in mathematics examinations, efficiency in students’ preparation and engagement with mathematics by senior cycle level must start much further back in the student’s schooling in order that appropriate techniques for engaging positively with mathematics are practised and built upon as the student progresses through secondary school. To this end, the teaching of study skills for mathematics can be effective as part of a holistic approach to engaging students with mathematics while addressing any potential anxieties towards mathematics (Buckley et al., 2016; Park et al., 2014).

9.2.3 The Role of the Second Level Mathematics Teacher

The experiences of mathematics teaching and learning in secondary school as recollected by these mature students have been negative for the majority of them regardless of nationality and level of mathematics anxiety; this has implications for second level
teachers in Ireland and internationally. The mathematics teacher has a significant influence on the development of attitudes about mathematics among students at second level, and the teacher’s attitude towards mathematics is pivotal in shaping the students’ experiences with mathematics (Morton, 2018; Park et al., 2014). In this regard, the teacher needs to address students’ concerns and difficulties with mathematics and having an awareness of the extent of students’ mathematics anxiety as they enter – and during – secondary school is pivotal in addressing mathematics anxiety and facilitating good feelings about mathematics. The teacher must also be attentive to the difficulties that certain mathematics topics present to students, especially more abstract topics like algebra, and when these are presented out of context (Boaler, 2016; Chinn, 2017; Haylock, 2018). However, teachers’ anxieties in respect of mathematics also need to be addressed both pre-service – in initial teacher education programmes – and in-service – through professional development – to ensure they maintain and present the right attitudes towards mathematics and use the most effective teaching methods in the mathematics classroom (Buckley et al., 2016; Trujillo & Hadfield, 1999). The approachability of the teacher is crucial if a student experiences difficulty with mathematics, and by the same token, the teacher needs to be aware of the students’ ability and understanding of mathematics in order that they do not get lost in the syllabus and fall behind. Further, timetabling of mathematics classes must reflect daily continuity with mathematics in order that students have contact with the subject and their mathematics teacher. The duration of mathematics class must also factor in time for questions and interaction between individual students and the teacher. This would be conducive to supporting the students with the challenges they encounter in their mathematics syllabus.

9.2.4 International Comparison Tests

The implications of the above findings have significance for Ireland’s performance in PISA tests, in that measures to counteract mathematics anxiety at second level, including more deliberate teaching methods, appropriate resources and supports for students, time for discussion around mathematics issues, as well as continued monitoring of mathematics anxiety, would help to address the negativity around mathematics, help students to feel better supported with mathematics, leading to an increased self-concept with mathematics, and ultimately impacting more positively on performance. If mathematics anxiety levels are reduced among primary and secondary students there will be a positive impact on these students’ performance and self-efficacy with mathematics,
leading to a positive effect on Ireland’s international ratings in terms of PISA, TIMSS and ultimately PIAAC assessments, and at national level in state examinations and matriculation requirements for higher education, and thereby adhering to the Literacy and Numeracy Learning for Life (LNLL) strategy objectives.

9.2.5 The Role of Parents

The findings have shown that—after the teacher—the parent has been the most significant person for these mature students as influencing their learning of mathematics. Recollections of parental involvement at primary level among these mature students were largely presented as the parent—particularly the mother—being supportive and explaining mathematics as fun and easy to understand. However, where students may have had the help of parents with primary school mathematics, for many students doing mathematics at second level the subject was brought to a new level beyond the scope of the parent’s ability, with the student being left devoid of parental help with mathematics. The findings present the role of the parent as significant for helping their children with mathematics, however, the parent is only able to help insofar as they understand the mathematics content; in this regard, the parent’s attitude towards mathematics is also significant, in that parents with a more positive disposition towards mathematics being more likely to influence their children’s learning of mathematics positively (Frentzel et al., 2010; Lane, 2017). Having the parent on-board with their children’s learning of mathematics is pivotal in fostering a positive attitude towards mathematics, but this is only effective where the parents understand the mathematics content and teacher’s methods of instruction. In this regard, there is a need for collaboration with parents from the outset at primary school in respect of mathematics learning, including during the transition process from primary to secondary school, and during the Junior and Senior Cycles. The use of in-school initiatives such as workshops for parents, as well as online resources can complement the classroom and home learning of mathematics (Smyth et al., 2004).

9.2.6 Mathematics in the Workplace

The findings show that all these students have experienced using mathematics in a work context, with varying degrees of exposure to mathematics expressed. The experiences of using mathematics in the workplace largely involved engagement with mathematics at a basic level; where these individuals experienced more challenging mathematics, they were typically not able to engage or not permitted to do so. For some this consolidated
the belief that they did not have the desired level of mathematics or that the mathematics required was above their ability. For some low and mid-range mathematics anxious mature students this experience enticed them to enter HE in order to obtain the required level of expertise. However, for high mathematics anxious mature students they only wanted to engage with mathematics in the workplace at a level they could understand and with guidance from superiors. Thus, these findings conveyed that the impression of the importance of mathematics in the workplace and corresponding attitude to mathematics is significant in facilitating understanding of the role of mathematics in workplace contexts and within different job designs (Hoyles et al., 2010; Keogh et al., 2014).

Initiatives that highlight the use and importance of mathematics in the workplace, as well as induction initiatives in the workplace would serve to show the extent of mathematics involved and the potential for advancement through training initiatives reflecting the use of mathematics. Not to address problems involving the use of mathematics in the workplace would be detrimental particularly to a highly mathematics anxious individual who would likely avoid work situations involving using mathematics, potentially limiting career advancement.

**9.2.7 Higher Education**

The findings of the study – particularly in relation to the MAS-UK test scores – pertain to how these mature students feel about mathematics at the time of completion of the questionnaire, namely while they are in higher education. The interviews with the twenty mature students elucidate these findings further, with responses on their ‘current’ engagement with mathematics also being elicited. While the MAS-UK results showed that these students have mainly low to moderate levels of mathematics anxiety, these scores disguise the specific contexts in which incidents of mathematics anxiety come to light (Henschel & Roick, 2018). Consequently, it is more revealing to consider the scores of the individual factors, which dictate levels of anxiety pertaining to the context for engaging with mathematics (Henschel & Roick, 2018). These findings show that situations of evaluation yield a higher range of mathematics anxiety scores compared with everyday uses of mathematics or observing mathematics being done. Thus, the prospect of doing a mathematics test or examination, or being asked to do a question in front of others is more likely to give rise to considerable anxiety among mature students.
9.2.8 Higher Education Mathematics Staff

The existence of mathematics anxiety among HE students must not go unnoticed or unmonitored by mathematics staff – lecturers, tutors and mathematics support staff – within HEIs. Having committed to enrol at the HEI, mature students must be invited to participate in a preparatory mathematics programme at their chosen HEI, in order that they are re-introduced to mathematics with a view to giving them an insight into the mathematics they are likely to encounter in their first mathematics module. However, the purpose of such preparatory programmes should not be simply about informing the prospective mature student. The findings of this study assert that a concerted effort must be made to find out the mathematics stories of mature students, with the intention of affording them the space to talk about what they have experienced in respect of learning mathematics. This opportunity is particularly beneficial to those mature students who have had negative experiences and who have not had the chance to talk about these before; it would also provide lecturers with valuable information on their students (Pritchard & Roberts, 2006) in order that they could better understand their predispositions to mathematics (Kyle & Kahn, 2009; LoPresto & Drake, 2004). Further, affording the prospective mature student the opportunity to revisit their mathematics life story may provide a constructive way of helping them to choose an appropriate course of study (Safford-Ramus, 2018).

9.2.9 Delivery of Service Mathematics Modules

The outcomes of this study lend themselves to informing practitioners in higher education about the issues facing mature students as they study service mathematics. The significance of the lecturer’s knowledge of andragogical principles and their role in the preparation, execution/delivery and evaluation of service mathematics cannot be underestimated and lend themselves to understanding the learning needs of all students in the class (Knowles et al., 2005). At the opening lecture of the service mathematics modules the lecturer needs to be aware that many students may be anxious about being there as well as about the content they have to engage with in the module. It would benefit the lecturer to have certain information on the students in the class, namely the extent of subject disciplines to ensure that the mathematics topics are presented with relevance to the respective disciplines, the age profile of students, thereby taking account of the mature students in the class, and the levels of mathematics anxiety among the cohort, whereby in
an Irish context the MAS-UK would be useful. The benefit of having students write their mathematics life story at the start of the module would enhance the lecturer’s understanding of any issues they have with mathematics (LoPresto & Drake, 2004).

There is merit in addressing the group of mature students independently of the bigger lecture forum in order that their background experience with mathematics can be elicited including their levels of anxiety towards mathematics. Where feasible, smaller lecture cohorts would be advantageous for service mathematics and would be less intimidating to students, facilitating opportunities for questions easier than in larger lectures (Miller-Reilly, 2006; Morton, 2009). In addition, a team-teaching approach with two lecturers conducting the lecture would provide additional expertise in the lecture and to the students (Lucas & Milford, 2009). Innovative teaching methods, including the flipped classroom and blended learning approaches to service mathematics would provide alternative, student-centred approaches to learning service mathematics (Bergmann & Sams, 2012; Zengin, 2017). The availability of approved online video resources to complement lectures and to counteract the inadequacies of non-legitimate resources would support mature students in their independent learning of service mathematics. Legitimate online sources of mathematics support need verification by mathematics departments in HEIs, as disparity between externally sourced resources and what is done by the lecturer can add to anxiety (Zengin, 2017). The involvement of lecturing staff in assisting the preparation and support of mature students before and during their undergraduate programme would contribute positively to the overall experience and likely retention of mature students in HE, thereby addressing national demands to attract and keep mature students in HE. The effectiveness of these suggestions depends on close collaboration between lecturers, tutors, and staff at the mathematics support centre in order that the appropriate resources and support measures are put in place and made accessible to mature students as they engage with mathematics throughout their programme of study.

9.2.10 Mature Students and Service Mathematics

Mature students intentionally choose what they want to learn, and what they choose has to have meaning, reflecting the ‘need to learn’ principle (Knowles et al., 2005); therefore, they choose a programme of study because of its perceived benefit to their lives. However, adults learning service mathematics may not choose to do so, as their main motivation is to study the programme of which service mathematics is a compulsory part
The findings of this study showed that a majority of mature students knew in advance of starting at the HEI that service mathematics would feature in their programme of study. However almost one quarter did not know. This is a concerning finding, and points to a deficit in communication about the programme from the HEI. Naming conventions for mathematics modules need to more transparently reflect the extent of service mathematics in a programme of study; however, this was not the experience of some mature students in this study. Consequently, HEIs should make explicit on promotional literature that mathematics features as an essential component in the chosen programme, and that they offer a preparatory course for incoming students before term begins, with mathematics support ongoing throughout the academic year.

Abstract concepts and symbols contribute to the challenges of mathematics when these are presented out of context. The presentation of mathematics without a suitable context is a missed opportunity on the part of the lecturer to engage the students at a deeper level. In this regard, the content of service mathematics modules would benefit by including reference to the history of the module topic, with the intention of helping students understand the significance of mathematics to the discipline and the context for the rules they subsequently have to engage with. This is particularly applicable to students with higher levels of mathematics anxiety, who frequently find that topics – particularly abstract concepts – do not make sense or seem relevant to their discipline of study. In order to enhance the relevance of mathematics content there needs to be a greater emphasis on linking mathematics with other modules or subjects. This would necessitate teachers working collaboratively to ensure the significance of mathematics is acknowledged and appreciated within other subject areas (Lucas & Milford, 2009).

9.2.11 Performance and Failure

The findings of this study have facilitated an insight into the effects of mathematics anxiety on performance – and vice versa – in the lives of mature students; the impact of mathematics anxiety for many of these students has been unfavourable leading to these students worrying, or panicking about the anticipation of doing mathematics as well as impacting negatively on their performance while doing mathematics homework or examinations; as a consequence, the outcome for many of these mature students has been a preference to not engage with mathematics where possible, and to apply coping strategies where mathematics is a required component of their education. In this way,
mature students are victims of a vicious cycle akin to Carey’s and colleagues’ ‘Reciprocal Theory’ (2016) whereby they will not perform to the best of their capability due to the impact of mathematics anxiety on performance, resulting from the impact of previous negative experiences leading to mathematics anxiety. The formation of attitudes towards mathematics leading to avoidance is detrimental to progress, thereby limiting many opportunities in education and work situations (Ashcraft & Krause, 2007; Fletcher & Cassady, 2010). It is essential that the potential harmful effects of such situations are conveyed to teachers at all levels of the education system, so that the teaching and learning of mathematics can reflect more positive attitudes towards the subject; further the potential for any situation of evaluation in mathematics to result in negative attitudes towards the subject needs to be detected as early as possible in the learner’s experiences with mathematics in order that they can be addressed and counteracted, and not allowed to accumulate over time. In addition, in HE mature students need timely reassurance of their progress with mathematics in order to building their confidence with the subject, and this needs to be factored in to the preparation and delivery of coursework and assessments by HE staff (Norton, 2009).

Failure of an examination can impact differently on students; it can be motivational, whereby the desired goal stimulates the student to move beyond the failure and have the motivation to move on (Duckworth et al., 2007; Dweck, 2017); or it can be detrimental, hindering performance, leading to disengagement with mathematics and avoidance of the subject, thereby consolidating their mathematics anxiety (Frenzel et al., 2007; Tobias, 1993). In this study some low mathematics anxious mature students experienced failure in mathematics at HE but were motivated to do better in their subsequent attempt at the examination. For many others especially with mid-range and high levels of mathematics anxiety, their anxiety towards mathematics in HE materialises as a fear of failure and they strive to pass the examination using whatever strategy works for them. Recollections of failure at secondary school impacted negatively on these students, demonstrating a reciprocal relationship between performance and mathematics anxiety akin to the Reciprocal Theory (Ashcraft et al., 2007; Carey et al., 2016); one student’s failure of a state examination impacted significantly on that student’s attitude towards mathematics subsequently, leading to a preference for avoidance of mathematics. Consequently, it is important that difficulties with mathematics that may result in failure or poor performance
are detected and addressed without resorting to achievement-related punishment, as endorsed by Frentzel, Pekrun and Goetz (2007).

**9.2.12 Mathematics Support**

Mature students rely on various levels of support for their learning; if the necessary supports are not provided by the HEI they will not be enticed to attend. Mathematics support is one of the key supports especially when students have service mathematics modules (Fitzmaurice *et al.*, 2015). The findings of this study highlighted the importance of mathematics support centres for mature students, although almost one quarter of this cohort were unaware of the mathematics support facilities at their HEI, and at one HEI in particular. Where students struggle practising questions by themselves, it is difficult to know if the question is answered right, and if they are using a calculator correctly. In this regard, reassurance from someone else – preferably a lecturer or tutor – is important, even more so in an examination context. Mathematics support centres are essential for mature students who are more likely to engage with their services throughout the academic term or year compared with traditional students. Their services need to be highly publicised – within the HEI, in promotional literature, on the institution’s website, in its social media presence – and accessible – so that opening hours and scheduling of support sessions are conducive to the needs of mature students. At the HEI’s open days and during induction programmes for new mature students the mathematics support centre should feature as part of the tour of campus facilities, thereby emphasising its significance as a dedicated centre and its presence as a tangible resource for students.

Despite showing varying levels of mathematics anxiety these mature students have learned to cope in various ways with the challenges in mathematics that they face and have done in the past. Mature students with low levels of mathematics anxiety – regardless of having had negative experiences in the past – have been able to cope and adopt a strategy that has resulted in a change of disposition towards mathematics which reflects more positive outcomes currently in respect of their beliefs about and attitudes to service mathematics. Awareness of strategies that mature students have used or use to overcome mathematics anxiety can assist lecturers in understanding the coping mechanisms of mature students engaging with mathematics. Mature students benefit from being able to talk with lecturers, especially after class (Pritchard & Roberts, 2006). This is particularly important to those mature students who seek assistance or reassurance with
mathematics. Students with higher levels of mathematics anxiety prefer the personal contact in respect of getting reassurance that they are doing mathematics the right way. Peer support would also be of benefit here (Kyle & Kahn, 2009), for example in the form of a buddying system for mature students of service mathematics, whereby a mature student in a later year of the same programme of study could mentor and assist the new mature student with mathematics; this was referred to as very beneficial by some of the mature students interviewed.

The identification of high mathematics anxious mature students at an early stage of the programme so they could avail of support with mathematics would be beneficial all round. Proven methods of dealing with mathematics anxiety include talking about past mathematics experiences (Elam & Cook, 2005; Tobias, 1993), bibliotherapy (Furner, 2004), expressive writing (Maloney & Beilock, 2012), approaching mathematics learning with a back-to-basics approach (Boaler, 2016; Kyle & Kahn, 2009), teaching mathematics at a slower pace and with streamed classes (Kyle & Kahn, 2009) if feasible. Lecturers and mathematics support staff need to enhance their own awareness (Kyle & Kahn, 2009) of how mathematics anxiety can be addressed. It would also be beneficial to mature students if service mathematics lecturers could allow some time at the end of lectures for mature students to talk to them about their concerns with the mathematics topics. In this way, lecturers can get a sense of whether students are getting lost or left behind with the mathematics topics by allowing some time to go through concepts again in detail; this may be necessary in order to engage any mature students at risk of falling behind.

9.2.13 Assessment of Service Mathematics

The findings of the study showed that mature students have a preference for doing continuous assessments in service mathematics, as it allows them to track their progress during the academic term. This finding lends itself to the need to review how service mathematics modules are assessed. New approaches to the assessment of service mathematics can increase the engagement and enthusiasm of mature students; for example, service mathematics lecturers working collaboratively with lecturers in other cognate modules; this approach has been utilised by the researcher with modules in business mathematics and management principles, leading to a joint/collaborative assessment component with relevance to both modules but highlighting the relevance of business mathematics to management and vice versa (Ryan, 2015). Learning outcomes
can be addressed using a variety of assessment types; the lecturer or module team would benefit from revisiting the learning outcomes and reviewing the prospect of using alternative methods of assessment where possible. Where a formal examination is the method of assessment, allowing the student to ask for help or have a break during the examination could help to alleviate any pressure and potentially avoid situations of panic with mathematics. In addition, flexibility in the timing of mathematics examinations would ease the pressure typically associated with the time limitation of the examination context.

9.2.14 Mature Students as a Focus

Much research involving mature students presents these students as a subset of a larger cohort under investigation studying in a particular discipline of study and across a range of HEIs. Thus, there is a dearth of research on the mature student learning service mathematics in HE and particularly in an Irish context. Thus, the researcher contends that the findings of this research will add new knowledge thereby addressing the deficit.

By focusing exclusively on mature students this study has contributed new findings that show how the profile of mature students in Ireland has evolved in almost two decades. More mature students are entering HE in their twenties compared with other age categories; almost one fifth of mature entrants is from overseas; and a majority of mature students is likely to enter HE from middle-class socio-economic backgrounds, with lower socio-economic categories being under-represented. Echoing the findings of two decades ago, there are still more male new entrant mature students in both Universities and Institutes of Technology, with a wider gender gap in the IoT sector. While the number of full-time mature student new entrants has almost doubled in the two decades, the percentage of part time mature student new entrants is the same.

Mature students overcome many challenges in order to engage effectively with their undergraduate programmes of study. Service mathematics is – for many mature students – one of these challenges (Fitzmaurice et al., 2015). The mature students that participated in this study have presented various levels of mathematics anxiety as facilitated through the MAS-UK test, and through their interview contributions have talked about diverse challenges posed by mathematics in different ways; some of these mature students embrace these challenges, actively seeking help, while having an appreciation of the benefit and relevance of the subject to their future careers. For others, engagement with
mathematics may represent the biggest academic challenge they have to face, and they do so with mixed feelings, comprising feelings about past experiences, as well as a motivation not to let their difficulties with mathematics have a detrimental effect on them.

What these mature students have experienced in HE service mathematics modules is reflective of more traditional approaches to teaching mathematics, with an emphasis on the teacher/lecturer talking. This approach does not suit mature students who need to learn by building on their existing experiences and knowledge (Knowles et al., 2005). However, their experiences at HE suggest teaching methods have not moved on much and need to benefit from professional development initiatives.

The characterisation of mathematics by these mature students has demonstrated a substantial awareness of the importance of mathematics as a subject; however mature students with relatively low levels of mathematics anxiety asserted the significance of mathematics to their programmes of study. In contrast, negative characterisations illustrated the complexity of mathematics for some students, and a sense of struggling with the subject, enhanced by the use of negative connotations such as dislike, unfriendly, fear and avoidance, and reflect the relatively higher levels of mathematics anxiety among this cohort.

Many of the issues faced by these mature students in respect of their engagement with mathematics may also have been experienced by traditional students; therefore, the latter cohort of students also warrants attention in respect of their anxiety towards mathematics. Attention also needs to be paid to the transition from second level school to higher education in respect of mathematics. This would necessitate close collaboration between second level mathematics teachers and HE mathematics lecturers. In this regard, the benefit of open days and taster lectures is worth emphasising.

There are many similarities with these students and mature students nationally and internationally who have varying levels of mathematics anxiety. While the literature presents an awareness of mature students as a heterogeneous cohort with many life experiences and much to contribute to the HE programmes of study, this awareness needs to be reinforced among HEI’s teaching and support staff. It is easy to address a cohort of students as if they all have had similar experiences; however, this is not the case in HE, and that needs to be reflected in the preparation and delivery of classes and support
sessions. Some mature students enter HE through further education and access programmes. In this regard, attention also is needed in terms of the transition from such programmes into HE and the role of mathematics in that transition.

9.3 Strengths of the Research

The methodological approach to this study afforded a rich insight into the research topic; the mixed methods research design allowed the researcher to examine the topic from different angles, with each method complementing the other to reveal a more complete picture (LoPresto & Drake, 2004) in respect of addressing the research aim.

9.3.1 The Questionnaire

The questionnaire as an instrument is useful in that it facilitates an efficient means of gathering data, especially using an online platform like Survey Monkey.com. However, the onus is on the recipient to complete the questionnaire and this can result in a lower return than might be desired. In this study, a total of four HEIs were targeted to distribute the questionnaire to their mature students, which resulted in 107 completed questionnaires out of a possible target cohort of 547 mature students. More responses would have been preferable. However, a total of ten HEIs either did not want to participate, or could not be contacted, or did not respond to the initial request to participate.

9.3.2 The Mathematics Anxiety Scale – UK

The MAS-UK provided a useful, concise, and easy to administer method of determining the levels of anxiety among these mature students at the time of completion of the questionnaire. However, the results of the MAS-UK test provide a number within a range which represents a snapshot of how anxious the student is; used alone, it provides an insight into the student’s overall level of anxiety, as well as affording the researcher the option to ascertain levels of anxiety in situations of mathematics evaluation, everyday/social mathematics, and mathematics observation; anxiety levels in individual scenarios (statements) can also be taken into consideration. However, the MAS-UK does not – and indeed it is not its purpose to – illuminate the backdrop for the levels of anxiety expressed. Therefore, a more thorough understanding of mathematics anxiety needs a complementary qualitative research method in order to delve deeper into the student’s past experiences with mathematics to help identify and expand on those incidents that have given rise to the level of mathematics anxiety the student currently feels. In this way
the understanding of what makes the student anxious is facilitated through elicitation of the ‘when’ and ‘why’ (LoPresto & Drake, 2004), thereby enriching the findings of the study.

Not to have used the MAS-UK in this study would have resulted in the loss of valuable data that inform the researcher where the student is at currently by means of measuring their level of mathematics anxiety. Thus, the mixed methods approach is pivotal in elucidating and enhancing understanding of mathematics anxiety among mature students.

Being able to compare the MAS-UK scores with the qualitative data from the interviews was very useful, in that it highlighted differences in the levels of the scores calculated compared with what the students said in their interviews. For example, one student, Jon, had a MAS-UK score of 59, but his account of his anxieties towards mathematics suggested he was more anxious that what his score proposed. With further examination, Jon’s scores for the Mathematics Evaluation Anxiety factor and the Mathematics Observation Anxiety factor collectively gave Jon a higher level of anxiety – with Jon scoring highest of all students on the Mathematics Observation Anxiety factor –, thereby reflecting a more realistic score to reflect what he had described in the interview. Similarly, Lynn’s and Kate’s MAS-UK scores of 57 and 61 respectively were not reflective of their accounts of negative experiences with mathematics in the interview. In contrast, James’s MAS-UK score of 83 was surprising, as he came across as being quite confident with mathematics in his interview; however, his confidence was paralleled by his accounts of the strategies he has used to succeed in mathematics examinations. These findings pose the question as to the validity of the MAS-UK test as a true measure of a student’s mathematics anxiety. Used by itself the MAS-UK provides a snapshot into the level of anxiety of the student towards mathematics; however, there is merit in analysing the separate factors to obtain a truer picture of the type of mathematics anxiety that is most persistent for the student, thereby reflecting the assertion of Henschel and Roick (2018); further, using the scale in conjunction with qualitative methods, such as the life story approach, can allow the qualitative data to elucidate the quantitative data (LoPresto & Drake, 2004).

9.3.3 The Interview Process – Life Story Method

The stories shared as part of the interview process were largely about past experiences, some of which happened decades ago. It is important to acknowledge that some details
may have been less distinct due to the passage of time, and the students’ awareness of my position as a lecturer in HE may have resulted in their versions of their stories being selective.

The adapted life story framework used to guide the interviews provided a succinct, but effective method to facilitate the sharing of students’ stories. The ten questions provided structure to the interview but handed over responsibility to the interviewee to share their stories with minimal talk from the interviewer, thereby lending itself to maximising the output of the interview context. In very few situations were the responses brief; however, the inexperience of the researcher in respect of conducting interviews combined with an awareness of the possibility of the interviewee being nervous likely resulted in this situation not having been maximised in terms of output.

9.3.4 Model of a Mathematics Anxiety Reaction

Cemen’s (1987) Model of a Mathematics Anxiety Reaction presents a useful framework with which to explore the antecedents of mathematics anxiety. However, the model lends itself to modification in respect of consideration of the extent of mathematics anxiety experienced from lower to higher levels. As this study has shown, there were instances of higher anxiety in the students’ past – environmental antecedents – which were overcome, resulting in lower levels of anxiety more recently; the MAS-UK would not reflect this. In this regard, some of the wording of the themes and sub-themes in the model can be adapted to reflect these eventualities – these modifications are presented in Appendix T; for example, instead of ‘lack of parental encouragement’ using simply ‘parental encouragement;’ the sub-themes of ‘teacher intimidation,’ ‘resources,’ ‘class duration,’ ‘scheduling of classes,’ ‘presenting a context for mathematics,’ and ‘mode of examination’ were new and warrant inclusion in the model. Further, the model necessitates reflection of the situation of the mature student engaging with mathematics with reference to their life experience and ability to reflect on their past engagement with mathematics; this would include such sub-themes as ‘past experiences in the workplace,’ ‘awareness of falling behind’ in learning and achievement of mathematics, and cognisance of the ‘relevance’ of mathematics.
9.4 Limitations of the Study

The limitations of this study pertain to the theoretical basis for mathematics anxiety, the data collection process, the focus on full-time mature students, and the duration of the research period.

9.4.1 Theoretical Basis for Mathematics Anxiety

The deficiency of an initial theoretical basis for the study of mathematics anxiety has posed difficulties for the interpretation and comparison of various studies, and consequently has impacted upon a lack of emphasis on the study of mathematics anxiety in curriculum development and in initial teacher education (McLeod, 1992; Zan et al., 2006).

9.4.2 Data Collection

It would have been preferable if the number of students who participated in the survey could have been more substantial. While the 107 completed questionnaires provided a significant amount of data with which to provide an insight into the mature students’ backgrounds and facilitated the measurement of their levels of mathematics anxiety, the volume of quantitative data would have provided even greater understanding of a wider variety of mature students. In this regard, it would have been preferable to have had access to mature students from more than four HEIs. This could have been facilitated by choosing a different time of year, as most contact was attempted during the July and August holiday period.

The MAS-UK was only completed once by the participants. If it had been done twice, it would have been a way of confirming the accuracy of the results.

The volume of qualitative data was considerable; although it did allow for good comparisons and contrasts to be made among the twenty mature students, it would have been more favourable to concentrate on fewer students and perhaps longer interviews or follow-up interviews to develop some of the themes in more detail. However, this hindsight can inform subsequent life-story interviews pertaining to research on mathematics anxiety among mature students.
9.4.3 Targeting Mature Students

The focus of this study was on full-time mature students; however, these make up a smaller proportion of all mature students in undergraduate education in Ireland. A future study would benefit from including part-time mature students, or by looking specifically at the case of part-time mature students.

9.4.4 Duration of Research

This research design provided a snapshot from one period of time into mathematics anxiety among mature students in Ireland, which was very much dictated by the Ph.D. research timeline and process. Owing to the iterative nature of mathematics anxiety and in consideration of the richness of the experiences conveyed by the mature students, this research topic would benefit from a longitudinal study over the duration of an undergraduate programme.

9.5 Future Research

As referred to in the previous section, a longitudinal study would be beneficial to capture the development of or change in feelings over the course of the mature student’s engagement with the programme – this is particularly relevant where the programme has numerous service mathematics modules extending over the duration of the programme.

It would be useful to interview teachers and have them talk about their experiences of students getting lost with mathematics and how they addressed that.

The prevalence of mathematics anxiety lends itself to investigation among different educational sectors and demographics, as well as within different socio-economic groups.

The impact of high levels of mathematics anxiety can be detrimental to student enrolment or progression with a course of study. Since mature students are likely to be well informed about what they are going to study, an investigation into the possible role of mathematics anxiety in the slow uptake of undergraduate programmes with service mathematics would be warranted.

If mathematics anxiety is understood nationally – and even internationally – as synonymous with being bad at mathematics, consequently the perception of mathematics anxiety and its potential debilitating effect on students needs to be publicised and
addressed at policy level, with commitment to the implementation of suitable means to address mathematics anxiety for teachers, students, and parents.

9.6 Conclusion

This study has provided an invaluable insight into what causes mature students to be anxious about mathematics in general and service mathematics in particular. This knowledge has helped the researcher to reflect on and amend her own practice in respect of catering to the needs of mature students with mathematics anxiety. For mature students, who may have been out of formal educational settings for a number of years, or even decades, their disposition towards the service mathematics they encounter in higher education has been considerably influenced by their past engagement with mathematics combined with their likely exposure to mathematics in work or everyday contexts, thereby providing additional lenses with which to view their attitudes towards mathematics (Goodson & Sikes, 2001). Thus, the onset of mathematics anxiety can be minimised or avoided completely by identifying at-risk students from an early age.

This study has demonstrated that an effective understanding of mathematics anxiety among mature students in Ireland warrants investigation into their past experiences from which stem many incidents with mathematics that have played a pivotal role in how they currently feel about and engage with mathematics. In addition, the role of the teacher is vital in embedding the right attitudes towards mathematics in students, and parents play an essential part in influencing and supporting their children’s early and sustained engagement with mathematics. It is also essential that HEIs – especially in the climate of widening access – are more inclusive of the variety of students that enrol and take dedicated and appropriate measures to address the needs and concerns of mature students.
References


Hoffmann, B. (2010). “I think I can, but I'm afraid to try”: The Role of Self-Efficacy Beliefs and Mathematics Anxiety in Mathematics Problem-Solving Efficiency, *Learning and Individual Differences* 20, pp. 276-283.


Appendices
Appendix A Publications, Conferences, Professional Development

Peer-Reviewed Publications


Conference Presentations


01 May  Mathematics Anxiety and the Mature Student, Women in Maths Day in Ireland (WIMDI) Conference, National University of Ireland, Galway

29 May  Service Mathematics and the Maths Anxious Mature Student, Limerick Postgraduate Research Conference (LPRC), Limerick Institute of Technology

2015  10-12 Jun.  The Prevalence of Mathematics Anxiety among Mature Students studying Service Mathematics in Ireland, Presentation at Institute of Mathematics and its Applications (IMA) First International Conference on Barriers and Enablers to Learning Mathematics: Enhancing Learning and Teaching for all Learners, University of Glasgow, UK

2016

04 Jul. Behind the numbers: Preliminary findings of a mixed methods study into the existence of mathematics anxiety among mature students, 23rd International Adults Learning Mathematics Conference (ALM-23), Maynooth University, Co. Kildare, Ireland, July 3rd-6th 2016

2017


04 Apr. Presentation of Ph.D. research topic to Interdisciplinary Research Group Meeting, Mary Immaculate College, St. Patrick’s Campus, Thurles.


2018


Professional Development Courses Undertaken

2013

01 May Dyscalculia identification and intervention Seminar, University of Limerick

08 Jun. Doctoral Workshop, University of Limerick

06 Dec. Prezi and Slideshare, University of Limerick
### 2014
- 28 Oct.  Questionnaire Design, University of Limerick

### 2015
- 16 Jan.  Working with Long Documents, University of Limerick
- 28 Apr.  Introduction to SPSS, University of Limerick
- 05 May  SPSS: Analyses of Categorical (Survey) Data, University of Limerick
- 29 Jun.-3 Jul. Ph.D. Writers’ Week, University of Limerick
- 20 Aug.  Reference Management: Focus on Endnote, University of Limerick

### 2016
- 20-24 Jun.  Ph.D. Writers’ Week, University of Limerick
- 03-04 Aug.  NVIVO software 1, University of Limerick
- 22 Aug.  Endnote referencing software, University of Limerick
- 27 Sep.  Effective Presentations, Mary Immaculate College

### 2017
- 27-28 Jul.  NVIVO software 2, University of Limerick.

### Conferences/Seminars/Workshops Attended

#### 2013
- 15-17 Feb.  International Winter School, University of Limerick
- 08 Mar.  ‘Why Maths Matters’ Conference, University of Limerick
- 30 Apr.  Women in Maths Day in Ireland (WIMDI), National University of Ireland, Galway
- 06-07 Jun.  IRMSS Mary Immaculate College summer school
- 13 Jun.  Doing the Maths: Numeracy Conference, Institute of Technology, Tallaght
- 29 Jun.  5th National Dyscalculia and Maths Learning Difficulties, Learning Works, Cumberland Hotel, London

#### 2014
28-29 Mar.  Doctoral Workshop, University of Limerick

12 May  Transition to Third Level Maths study; the increasing relevance and development of maths support, Teaching and Learning Seminar, Cork Institute of Technology

13 May  Developing and Enhancing Pedagogic Research Skills in STEM Disciplines, Teaching and Learning Seminar, Maynooth University

15 May  Transitioning critical skills and research knowledge when working with adult learners and mature students: teaching and learning perspectives, Teaching and Learning Seminar, University College Cork

28 Jun.  Doctoral Workshop, University of Limerick

2015

30 Jan. - 1 Feb. International Winter School, University of Limerick

19 Mar.  Exploring and Sharing My Classroom Practice, Education Symposium, St. Patrick’s College, Thurles.

2016

19-21 Feb.  International Winter School, University of Limerick

2017

27-28 Jan.  International Winter School, University of Limerick

10 Jun.  Goodall, J. Parental Engagement to Enhance Children’s Learning, Keynote Address at National Parents’ Council AGM, National College of Ireland, Dublin.

2018

24 Nov.  Doctoral Workshop, University of Limerick
Appendix B Cemen’s (1987) Model of a Mathematics Anxiety Reaction

<table>
<thead>
<tr>
<th>Category of Antecedent</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Antecedents</td>
<td>Lack of Parental Encouragement</td>
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<tr>
<td></td>
<td>- Attempts to help</td>
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<td></td>
<td>- Encouragement in belief and worth</td>
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<tr>
<td>Negative Experiences</td>
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<td></td>
<td>- Lack of success in front of Teacher/ Parent</td>
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<td></td>
<td>- Embarrassment</td>
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<td></td>
<td>- Feeling stupid</td>
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<td>- Teacher perception of Student’s ability</td>
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<td></td>
<td>- Demand for correctness</td>
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<td></td>
<td>- Lack of cognitive and emotional support</td>
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<td></td>
<td>- Reluctant to seek help from Teacher</td>
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<td></td>
<td>- Punishment</td>
</tr>
<tr>
<td>Mathematics achievement below expectation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Link between achievement and anxiety</td>
</tr>
<tr>
<td>Dispositional Antecedents</td>
<td>Self-doubt</td>
</tr>
<tr>
<td></td>
<td>- Perception of being no good at Mathematics</td>
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<td></td>
<td>- Poor study skills/preparation</td>
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<td></td>
<td>- Impact of failure and repeated failure</td>
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<tr>
<td>Lack of confidence</td>
<td></td>
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<tr>
<td>Attitudes to mathematics</td>
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<tr>
<td></td>
<td>- Perceived usefulness of mathematics</td>
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<td></td>
<td>- Mathematics as male domain</td>
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<tr>
<td>Sex role/social stereotype</td>
<td></td>
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<tr>
<td>Prior avoidance</td>
<td></td>
</tr>
<tr>
<td>Situational Antecedents</td>
<td>The Nature of Mathematics</td>
</tr>
<tr>
<td></td>
<td>- Topics</td>
</tr>
<tr>
<td></td>
<td>- Cumulative nature</td>
</tr>
<tr>
<td></td>
<td>- Abstractness</td>
</tr>
<tr>
<td></td>
<td>- Exactness/perfection</td>
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<tr>
<td></td>
<td>- Can’t make up for missed work</td>
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<tr>
<td>Classroom factors</td>
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<td></td>
<td>- Teacher personality</td>
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<td></td>
<td>- Class size</td>
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<tr>
<td></td>
<td>- Time limitation</td>
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<tr>
<td></td>
<td>- Public setting</td>
</tr>
<tr>
<td>The way mathematics is taught</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Pace</td>
</tr>
<tr>
<td></td>
<td>- Teacher methods</td>
</tr>
<tr>
<td>Test anxiety</td>
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</tr>
<tr>
<td></td>
<td>- Level of preparation for test</td>
</tr>
<tr>
<td></td>
<td>- Importance of test</td>
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<tr>
<td></td>
<td>- Having a time limit</td>
</tr>
</tbody>
</table>
## Appendix C Tests for assessing Mathematics Anxiety

<table>
<thead>
<tr>
<th>Year and Author(s)</th>
<th>Name of Test</th>
<th>Target Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972 R.M. Suinn, C.A. Edie, E. Nicoletti, P.R. Spinelli</td>
<td>Mathematics Anxiety Rating Scale (MARS) 98-item scale</td>
<td>Undergraduate students</td>
</tr>
<tr>
<td>1976 E. Fennema, J. A. Sherman</td>
<td>Fennema-Sherman Mathematics Attitudes Scales - Mathematics Anxiety Scale (12-item)</td>
<td>Second Level/High-School/Pre-College Students</td>
</tr>
<tr>
<td>1978 N. Betz</td>
<td>Mathematics Anxiety Scale (adaptation of Fennema-Sherman Mathematics Anxiety Scale)</td>
<td>Undergraduate Students</td>
</tr>
<tr>
<td>1979 R. S. Sandman</td>
<td>Anxiety Towards Mathematics Scale (6-item)</td>
<td>Second Level Students Grades 7 to 12</td>
</tr>
<tr>
<td>1982 B.S. Plake, C.S. Parker</td>
<td>Revised Mathematics Anxiety Rating Scale (MARS-R) (24-item)</td>
<td>Undergraduate Students</td>
</tr>
<tr>
<td>1982 R.M. Suinn, R. Edwards</td>
<td>Mathematics Anxiety Rating Scale for Adolescents (MARS-A)</td>
<td>Adolescents</td>
</tr>
<tr>
<td>1988 A. Wigfield, J. L. Meece</td>
<td>Math Anxiety Questionnaire (MAQ) (11-item)</td>
<td>Primary/Elementary and Second Level Students Grades 5 to 12</td>
</tr>
<tr>
<td>1989 L. Alexander, C. R. Martray</td>
<td>Shortened Mathematics Anxiety Rating Scale (S-MARS) (25-item)</td>
<td>College Students</td>
</tr>
<tr>
<td>1990 L. Chiu, L. L. Henry</td>
<td>Mathematics Anxiety Scale for Children (MASC)</td>
<td>Primary/Elementary School Students</td>
</tr>
<tr>
<td>2000 G. Thomas A. Dowker</td>
<td>Mathematics Attitude and Anxiety Questionnaire</td>
<td>Primary/Elementary School Students</td>
</tr>
<tr>
<td>2003 R.M. Suinn, E.H. Winston</td>
<td>30-item Mathematics Anxiety Rating Scale (MARS-30)</td>
<td>Undergraduate Students</td>
</tr>
<tr>
<td>2003 D. R. Hopko, R. Mahadevan, R. L. Bare, M. K. Hunt</td>
<td>Abbreviated Mathematics Anxiety Scale (AMAS) (9-item)</td>
<td>Undergraduate Students</td>
</tr>
<tr>
<td>2007 H. Krinzinger, L. Kaufmann A. Dowker, G. Thomas, M. Graf, H. C. Nuerk</td>
<td>Fragebogen für Rechenangst (Mathematics Anxiety Questionnaire German version for children aged 6 to 9)</td>
<td>Primary/Elementary School Students aged 6-9</td>
</tr>
<tr>
<td>2011 T.E. Hunt, D. Clark-Carter, D. Sheffield</td>
<td>Mathematics Anxiety Scale – UK (MAS-UK)</td>
<td>Undergraduate Students and Adults</td>
</tr>
<tr>
<td>2013 M. M. Jameson</td>
<td>Children’s Attitudes to Mathematics Scale</td>
<td>Primary/Elementary School Students</td>
</tr>
<tr>
<td>2014 N.I. Núñez-Peña, G. Guilera M. Suárez-Pellicioni</td>
<td>Single-Item Mathematics Anxiety (SIMA) scale</td>
<td>Undergraduate Students</td>
</tr>
<tr>
<td>2017 E. Carey, A. Devine, F. Hill, D. Szűcs</td>
<td>Modified Adolescent Mathematics Anxiety Scale (mAMAS)</td>
<td>Older Primary School Children and Adolescents</td>
</tr>
<tr>
<td>2019 T.E. Hunt, O. Bagdasar D. Sheffield, M.B. Schofield</td>
<td>Mathematics Calculation Anxiety Scale</td>
<td>Undergraduate Students and Adults</td>
</tr>
</tbody>
</table>
Appendix D Subject Information Sheet

Title of Project: The existence of mathematics anxiety among mature students learning service mathematics in Ireland

The Study: This project is investigating:

- To what extent does mathematics anxiety exist among mature students studying service mathematics in Higher Education in Ireland?
- To what extent do present encounters with mathematics trigger Mathematics Anxiety?
- To what extent do specific incidents in a mature student's life story give rise to the Mathematics Anxiety that these students experience?
- What coping mechanisms do these mature students use to deal with their Mathematics Anxiety?

Participation Information:

There are no risks involved in this study. You will be asked to complete a questionnaire, and subsequently, with your consent, you may be invited to participate in a one-to-one interview which will be audio-recorded and take approximately 60 minutes to complete.

All information gathered will remain confidential and used only for the purpose of this study. No information re. subjects will be identified in the final report. It will be stored safely with access only available to the investigator.

You are under no obligation to participate in this study and are free to withdraw at any stage. Should you have any questions or do not understand something just ask the investigator to clarify the issue. Only students over the age of 18 will be asked to participate.

Contact Details:
Ms. Maria Ryan, Ph.D. (Education) Candidate, maria.ryan@ul.ie
Dr. Olivia Fitzmaurice, Department of Mathematics & Statistics, University of Limerick, 061-202012

If you have concerns about this study and wish to contact someone independent, you may contact:

Dr. Thomas Waldmann, Chair of Faculty of Science & Engineering Research Ethics Committee, University of Limerick. Tel: 061 202802.
Appendix E Questionnaire

Project Title

The Existence of Mathematics Anxiety among Mature Students learning Service Mathematics in Ireland

Thank you for taking part in my research study, which is being carried out as part of my Ph.D. studies at the University of Limerick. The questionnaire represents Phase 1 of my research, and can be completed without the need for your name or contact details.

In Phase 2 of my research, I will ask people to share their experiences of mathematics from school years onwards. If you would like to be considered for participation in Phase 2, please complete the section below.

I would like to participate in Phase 2 of the above research project. I understand that my participation is voluntary and that I may withdraw at any time. You have my permission to contact me and I have indicated my contact preference(s) and details below:

Phone me on (contact number): ________________________________

Text me on (contact number): ________________________________

Email me at (email address): ________________________________

Signed: ________________________________ Date: ____________________
Section 1: Personal information

The purpose of this section is to collect some information about the mature students attending this Higher Education Institution (HEI). The information you provide will be used only for this research project.

<table>
<thead>
<tr>
<th>Gender: M / F</th>
<th>Date of Birth:</th>
<th>First language:</th>
</tr>
</thead>
</table>

1. What is the Discipline of your programme of study at this HEI? (please tick)
   - Education
   - Engineering, Manufacturing and Construction
   - Health and Welfare
   - Humanities and Arts
   - Science, Mathematics and Computing
   - Services
   - Social Sciences, Business and Law
   - Other (please specify):

2. What level programme are you studying?
   - Level 6: Higher or Advanced Certificate
   - Level 7: Ordinary Bachelor’s Degree/Diploma
   - Level 8: Honours Bachelor’s Degree/Higher Diploma
   - Other (please specify):

3. Is this programme (please tick): **Full time** □ **Part time** □ **Other (please specify)**

4. Does the programme have a mathematics module? **Yes** / **No** / **Don’t know**
   
   If **YES**, were you aware of this before you applied for the programme? **Yes** / **No**

5. Before starting this programme, did you update your mathematics knowledge? **Yes** / **No**
   
   If **YES**, did you: (please tick all that apply)
   - Attend a preparatory mathematics programme at this HEI
   - Attend a preparatory mathematics programme at another HEI
   - Obtain private tuition/grinds in mathematics
   - Engage in self-study of mathematics
   - Other (please specify):

6. Have you completed any other programme of study since you left school? **Yes** / **No**
   
   If **YES**, how did you feel about the mathematics in that programme (if applicable)?

7. What year did you leave school? __________________________
8. On a scale of 1 to 10 (1=lowest, 10=highest) how would you rate your ability in mathematics:

<table>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Not Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>At primary school</td>
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<td>At secondary school</td>
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<td>Since leaving school</td>
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<td>Today</td>
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</tbody>
</table>

9. Are you aware of the mathematics support service at this HEI? **Yes / No / Not relevant**

10. Do you intend using the mathematics support service at this HEI? **Yes / No / Don’t know**

11. Do you envisage that your future career will involve mathematics? **Yes / No / Don’t know**

12. On a scale of 1 to 10 (1= Not anxious, 10 = Extremely anxious) how do you feel about mathematics right now?

<table>
<thead>
<tr>
<th>Not Anxious</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Extremely anxious</th>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

P.T.O.
Section 2: The Mathematics Anxiety Scale – UK26

The purpose of this section is to collect information about the extent of mathematics anxiety among mature students at this HEI. The information you provide will be used only for this research project. For each of the 23 statements listed below, please show how you feel about each of the statements right now (rather than in the past, for example) by circling one of the numbers from 1-5. Each number represents a measurement:

1 = not at all
2 = slightly
3 = a fair amount
4 = much
5 = very much

Please measure all 23 statements.

How anxious would you feel in the following situations right now? Please circle one number (1 to 5) for each statement.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Not at all</th>
<th>Slightly</th>
<th>A fair amount</th>
<th>Much</th>
<th>Very much</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Having someone watch you multiply 12x23 on paper</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Adding up a pile of change</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Being asked to write an answer on the board at the front of a maths class</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Being asked to add up the number of people in a room</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>Calculating how many days until a person’s birthday</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>Taking a maths exam</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>Being asked to calculate €9.36 divided by 4 in front of several people</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>Being given a telephone number and having to remember it</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>Reading the word ‘algebra’</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>Calculating a series of multiplication problems on paper</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11</td>
<td>Working out how much time you have left before you set off for work or place of study</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12</td>
<td>Listening to someone talk about maths</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13</td>
<td>Working out how much change a cashier should have given you in a shop after buying several items</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>14</td>
<td>Deciding how much each person should give you after you buy an object that you are all sharing the cost of</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>15</td>
<td>Reading a maths textbook</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>16</td>
<td>Watching someone work out an algebra problem</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>17</td>
<td>Sitting in a maths class</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>18</td>
<td>Being given a surprise maths test in a class</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>19</td>
<td>Being asked to memorise a multiplication table</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>20</td>
<td>Watching a teacher/lecturer write equations on the board</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>21</td>
<td>Being asked to calculate three fifths as a percentage</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>22</td>
<td>Working out how much your shopping bill comes to</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>23</td>
<td>Being asked a maths question by a teacher/lecturer in front of a class</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Thank you for your contribution. Please use the space below to add any comments.

---

Appendix F Email to Mature Students about the Research

Mature Student and Mathematics Anxiety Questionnaire
Maria Ryan
Sent: 28 September 2015 15:15
To: mdryan@stpats.ie

Dear Student,

It was lovely to have the opportunity to talk with you at your induction day a few weeks ago. Thank you for your interest in my research project which aims to explore the extent of Mathematics Anxiety among Mature Students.

Below is the link to my questionnaire which comprises Phase 1 of my Ph.D. research.

https://www.surveymonkey.com/r/MathematicsAndTheMatureStudent

I look forward to receiving your completed questionnaires, and as an added incentive, there will be a draw for a One-4-All gift card among all year 1 mature students at [HEI] who complete this questionnaire.

If you have any queries about this questionnaire, please email me.

I wish you the best with your studies at [HEI].

Maria Ryan
Appendix G Consent Form

CONSENT FORM

I, the undersigned, declare that I am willing to take part in research for the project entitled “The Existence of Mathematics Anxiety among Mature Students learning Service Mathematics in Ireland”.

• I declare that I have been fully briefed on the nature of this study and my role in it and have been given the opportunity to ask questions before agreeing to participate.

• The nature of my participation has been explained to me and I have full knowledge of how the information collected will be used.

• I am also aware that if I agree to participate in Phase 2 of this study, the interview will be audio-recorded and I agree to this. However, should I feel uncomfortable at any time I can request that the recording equipment be switched off. I am entitled to copies of all recordings made and am fully informed as to what will happen to these recordings once the study is completed.

• I fully understand that there is no obligation on me to participate in this study

• I fully understand that I am free to withdraw my participation at any time without having to explain or give a reason

• I am also entitled to full confidentiality in terms of my participation and personal details

_____________________________  ______________________
Signature of participant                  Date
Appendix H Email sent to Mature Student Officer/Access Officer at HEI

From: Maria.Ryan
Sent: 28 September 2015 14:46
To: xxxxx@xxxxx
Subject: Distribution of Questionnaire to Mature Students

Good afternoon,

Further to my recent visit to [HEI], as well as my previous correspondence relating to my Ph.D. research which aims to explore the extent of Mathematics Anxiety among Mature Students, please find below the link to my questionnaire to be forwarded to mature students at [HEI], and which comprises Phase 1 of my Ph.D. research.

https://www.surveymonkey.com/r/MathematicsAndTheMatureStudent

I look forward to working with the mature students at [HEI] over the coming months as my research phases roll out. There will also be a draw for a One-4-All gift card among all those mature students at [HEI] who participate in Phase 1 (completion of the questionnaire).

I want to thank you for your assistance with my research to-date, and also for assisting in the distribution of this questionnaire by email link.

If you have any queries about my research, please contact me by email (maria.ryan@ul.ie) or by phone (087-2773824).

With kind regards,
Maria
Appendix I Reminder Email to Mature Students

Mature Student and Mathematics Anxiety Questionnaire
From: Maria.Ryan mdryan@stpats.ie
Sent:22 October 2015 09:49
To: [mature students]

Dear Student,

Thank you for your interest in my research project which aims to explore the extent of Mathematics Anxiety among Mature Students. I would like to let you know that my questionnaire is still live, and, if you haven't done so already, I would appreciate your contribution by clicking on the link below and answering the questions online; this should take no more than 10 minutes of your time.

https://www.surveymonkey.com/r/MathematicsAndTheMatureStudent

I look forward to receiving your completed questionnaires, and as an added incentive, there will be a draw for a €100 One-4-All gift card among all year 1 mature students at [HEI] who complete this questionnaire.

If you have any queries about this questionnaire, please email me.

I wish you the best with your studies at [HEI].

Maria Ryan
Appendix J Email Correspondence with Dr. Thomas Hunt
(presented in reverse chronological order)

From: Thomas Hunt [mailto:T.Hunt@derby.ac.uk]
Sent: 24 November 2015 10:19
To: Maria Ryan <MDRyan@stpats.ie>
Subject: RE: Request for Permission to use MAS-UK in Ph.D. Research

Hi Maria

Research never quite goes to plan does it?! Yes, that’s absolutely fine □
Please do let me know if there’s anything I can help with or contribute.

Best
Tom

From: Maria Ryan [mailto:MDRyan@stpats.ie]
Sent: 24 November 2015 10:17
To: Thomas Hunt
Subject: Request for Permission to use MAS-UK in Ph.D. Research

Good morning Tom,

You might recall I contacted you in February asking your permission to use your MAS-UK scale in my research, and you very kindly agreed. My intention then was to distribute a paper questionnaire including the MAS-UK to my target group; however, this option did not work out for me and I have had to put the questionnaire in an online format (using SurveyMonkey.com).

In this regard, I would like to once again ask your permission to distribute the MAS-UK in this online format to the cohort of year 1 mature students. The other parameters of my research remain the same, as per my proposal.

I look forward to hearing from you.
With kind regards,
Maria

From: Maria Ryan
Sent: 26 February 2015 14:11
To: Thomas Hunt
Subject: Re: Request for Permission to use MAS-UK in Ph.D. Research

Hi Tom,

Thank you for your email. I am delighted to be able to use the MAS-UK, as I feel it fits very well with my intended research, particularly with the focus on mature students. I also appreciate the articles you sent me, and I will certainly keep you informed according as my research progresses.

With kind regards,
Maria
From: Thomas Hunt <T.Hunt@derby.ac.uk>
Sent: 26 February 2015 13:34
To: Maria Ryan
Subject: RE: Request for Permission to use MAS-UK in Ph.D. Research

Hi Maria

Thanks for your email. This looks like really interesting stuff and ties in with some of the work I’m doing at the moment looking at previous maths experiences, albeit from a quantitative perspective. You’re more than welcome to use the MAS-UK – I’ve attached the paper it was published in along with a separate document just with the scale. In case they’re useful here are a couple of other recent papers.

Please do keep me in the loop regarding your research!

Best Wishes
Tom

Dr Thomas Hunt, FHEA
Lecturer in Psychology & Joint Honours Subject Lead for Psychology,
Room N202a,
Department of Life Sciences, College of Life and Natural Sciences,
University of Derby
Kedleston Road, Derby, DE22 1GB
+44 (0)1332 592015
t.hunt@derby.ac.uk
Skype: dr_tom_hunt

From: Maria Ryan [mailto:MDRyan@stpats.ie]
Sent: 26 February 2015 11:56
To: Thomas Hunt
Subject: Request for Permission to use MAS-UK in Ph.D. Research

Good morning Dr. Hunt,

I would like to request your permission to use the MAS-UK within a questionnaire I intend to distribute as part of my Ph.D. research. My research is exploring the extent of mathematics anxiety among mature students studying service mathematics at third level in Ireland. The questionnaire comprises part one of a two-phase approach to the research, and will be used to identify candidates with varying levels of maths anxiety, from whom a selection will be invited to participate in one-to-one life-history interviews.

For your information I have attached a copy of my research proposal. I would appreciate any comments or suggestions you might have in respect of my research idea. I look forward to hearing from you at your earliest convenience.

With kind regards,
Maria Ryan

Maria D. Ryan (Ph.D. Candidate)
Lecturer, Department of Business Studies
St Patrick’s College, Cathedral Street, Thurles, Co Tipperary
T: 0504-21201
E: mdryan@stpats.ie
Hi all,

I hope the summer is treating you all well. I am wondering if you could fill out the attached questionnaire and send it back to Maria.Ryan@ul.ie (cc’d on this email). It should not take very long and will provide her with valuable information that will help mature students and their tutors in the coming years.

As you are filling this out electronically I am sure that you can make some of the boxes bold or coloured (instead of ticking them) and make the numbers bold or coloured (instead of circling them).

It would be greatly appreciated if you could help with this. Enjoy your time off and I will hopefully see some of you next year.

Kind regards,
Ricky

Richard Walsh,
Co-ordinator,
Mathematics Learning Centre,
A2-018a,
University of Limerick.
Phone: +353 61 202512
E-mail: richard.walsh@ul.ie
Web: www.mlc.ul.ie
Appendix L Email Correspondence with Ethics Committee Requesting Change to Format of Questionnaire from Paper to SurveyMonkey.com Hyperlink

(presented in reverse chronological order)

From: Eileen.Madden
Sent: 24 November 2015 11:50
To: Maria.Ryan
Cc: Eileen.Madden
Subject: RE: Update to ethics submission

Hi Maria

Your amendment has been approved by the Ethics Chair, you do not have to resubmit.

Regards
Eileen

From: Maria.Ryan
Sent: 24 November 2015 10:09
To: Eileen.Madden
Subject: Update to ethics submission

Good morning Eileen,

I had my annual progression review in October and as a result of the discussion, I need to make a change to my original Ethics submission.

Originally, I had said I would distribute a (paper) questionnaire to first year mature students. However, this did not work out as planned, and I have had to put the questionnaire online, using SurveyMonkey.com, and email it to the students by way of the Mature Student Office/Access office at the institutions I am surveying. They then forward the email with the link to my questionnaire to the first year mature students at the institution.

Can you advise, Eileen, if I have to re-submit the entire form to reflect this? The reference number and title are:

2015_02_03_S&E, The Existence of Mathematics Anxiety among mature students learning Service Mathematics in Ireland,
Investigator(s): Olivia Fitzmaurice, Maria Ryan

I look forward to hearing from you.

Kind regards,
Maria Ryan
Appendix M Invitation to Participate in Phase 2 of Research

Invitation to Participate in Research on Mathematics and the Mature Student
Maria Ryan [MDRyan@stpats.ie]
Sent: 24 March 2016 15:58
To: Maria.Ryan
Attachments: Information Sheet for Stud--1.pdf (79 KB); CONSENT FORM.docx (24 KB)

Dear Student,

Thank you for completing my online questionnaire during September/October 2015. As you might recall, the purpose of my research project is to explore the existence of negative feelings towards mathematics among mature students learning service mathematics in Ireland.

Having analysed the online questionnaire you completed, you have been identified as a mature student who could make a considerable contribution to this research project. Your participation will require the following commitment from you:

1. **Timeline**: In advance of meeting me for interview, I will invite you to think about your engagement with mathematics and put together a timeline of significant experiences that made you think or feel about mathematics in a different way; you can do this on paper or electronically using a Word document, for example. The purpose of the timeline is to indicate negative and positive experiences, as well as turning points in your relationship with maths throughout your life. You can include experiences from primary and secondary school, outside of school, work, family life, third level, and any other significant influences. The completed timeline will form the basis for the interview discussion when we meet, so I invite you to email this to me (as an attachment) before we meet for interview.

2. **Interview**: I will meet with you for approximately one hour to talk about your relationship with mathematics, focusing on your timeline and your experiences with maths throughout your life. The interview will take place during the next few weeks and will be audio recorded and transcribed. The location of this interview will be on campus at [HEI] at a location which will preserve your confidentiality and anonymity and allow the audio recording of the interview. The interview will take place at a time and date that will be agreed by both of us.

3. **Journal/Diary**: After the interview, you may think of other events or recall other memories of mathematics that you feel may be significant. I invite you to keep a record of these and email the details of these events to me before the end of June 2016.

I hope you will be able to participate in this phase of my research. I have attached the Information Sheet and Consent Form for your information. If you would like to participate, please complete and return the consent form by email attachment to maria.ryan@ul.ie as soon as possible. If you need further information about my study or further clarification on any aspect of this phase of the research, please email me or contact my supervisor, Dr. Olivia Fitzmaurice.

Yours sincerely,

Maria Ryan (Ph.D. Candidate)          Dr. Olivia Fitzmaurice (Supervisor)
Maria.Ryan@ul.ie                  061-202012 / Olivia.Fitzmaurice@ul.ie
Appendix N Sample Timeline

1976 born

1992 Junior cert. Ordinary? maths A

1993 I was transferred to higher level Maths. (Kicked out after a week)

1994 Leaving certificate. Ordinary Maths A2

1994-2013 Did not use maths much. Tended to work in imperial measurements.

2011 Signed up for online courses including maths physics (City)

2012 Signed up for online maths (The Khan Academy)

2013 Joined community college basic engineering course (level 5/6)

A maths requirement was part of this course. It went very rapidly from long division to basic integration. Nothing on this course was familiar (managed a distinction)

An extra maths course was organised by the college with the intention of students sitting or re-sitting leaving cert maths. I signed up for this.

Tried preparing for leaving cert maths with "less stress more success" booklet

2014 Managed a C in higher maths. (expected to fail)

Attended a 2 week pre-semester maths course run by the maths support centre. The maths was useful but at too low a level for engineering

2015 semester 1 Biomedical engineering. Maths was at a very fast revision pace. My mind was far too fuzzy to learn much. There were three hours maths scheduled sequentially. Very demoralising. Managed a B1 in maths. (expected to fail) My mind was still fuzzy for weeks after the exams

Went to the maths support centre for help. The system there does not suit my nature. I filled in an online questionnaire (for the tutors?). I said nice things but was surprisingly upset afterwards. Maybe it was because I knew I needed help but was too exhausted to be able to use it anyway. (it was available)

2016 semester 2. Maths was at a slower pace? (v good tutor)

2016 summer. I plan to continue with online courses
Appendix O Codebook for Interview Transcript Analysis

The following is the list of thematic nodes exported from NVIVO and gives the name and description of each code. The thematic nodes represent the McAdams’s Framework headings (Framework Categories) and were populated using relevant codes (Nodes) from the interview transcripts (Sources), and the collective references to the specific node (Reference). Where a Name is indented indicates a sub-heading (subfolder).

**Framework Categories**
Categories determined by the adapted McAdams's Framework and used in the interviews

**Nodes\ Framework Categories\Feelings about Mathematics in General**
Reference to how the student feels about mathematics at the time of interview

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Sources</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feel about mathematics</td>
<td>Reference to how the student feels about mathematics in general - opening question to interview</td>
<td>20</td>
<td>26</td>
</tr>
</tbody>
</table>

**Nodes\ Framework Categories\Mathematics after School**
Reference to engaging with mathematics after formal schooling had finished, including using mathematics in a work environment.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Sources</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics after schooling</td>
<td>Reference to engagement with mathematics after the mature student had completed schooling.</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td>Mathematics as important</td>
<td>Reference to mathematics as being important</td>
<td>6</td>
<td>15</td>
</tr>
</tbody>
</table>

**Nodes\ Framework Categories\Mathematics at Third Level**
Reference to doing or learning mathematics as a mature student at third level.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Sources</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class duration</td>
<td>Reference to duration of mathematics class</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Classroom</td>
<td>Reference to the class room where mathematics class (class, lecture, tutorial) is held</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Confusion</td>
<td>Reference to mathematics being confusing for the student</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Deferral</td>
<td>Reference to deferral of a programme of study</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Difference between IoT and Uni</td>
<td>Reference to the student experiencing a difference between the IoT and the Uni</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Sources</td>
<td>Reference</td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td>Mathematics at third level - Service Mathematics</td>
<td>Reference to the mathematics modules the student is doing at third level</td>
<td>20</td>
<td>82</td>
</tr>
<tr>
<td>Pace of third level class</td>
<td>Reference to the pace of mathematics classes at third level, lectures and tutorials</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>Scribe</td>
<td>Reference to the student having access to a scribe to assist with examinations</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Shock to the system</td>
<td>In vivo reference to the student's feeling about the amount of mathematics in the programme of study</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Short term memory</td>
<td>Reference to the use of short term memory in studying mathematics for examinations or tests</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Step-by-step</td>
<td>Reference to student approaching mathematics step-by-step</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Support in or outside HEI</td>
<td>Reference to support with mathematics as provided to the student by another individual</td>
<td>20</td>
<td>78</td>
</tr>
<tr>
<td>Tutorials</td>
<td>Reference to tutorials at third level</td>
<td>6</td>
<td>13</td>
</tr>
</tbody>
</table>

**Nodes\ Framework Categories\ Mathematics in Adolescence**

Reference to doing or learning mathematics as an adolescent, during or outside of post-primary school.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Sources</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absence</td>
<td>Reference to student being absent from school/college</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Changed schools</td>
<td>Reference to the student having changed schools</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Class duration</td>
<td>Reference to duration of mathematics class</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Keeping up</td>
<td>In vivo reference to student being able to keep up with the rest of the class</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Leaving Certificate</td>
<td>Reference to the Leaving Certificate syllabus and/or examination</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>Messing</td>
<td>Reference to student misbehaviour or 'messing' in class</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Secondary school experience</td>
<td>Reference to experience of doing mathematics at secondary school</td>
<td>20</td>
<td>86</td>
</tr>
</tbody>
</table>

443
<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Sources</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Streaming</td>
<td>Reference to streaming of students into different class groups</td>
<td>8</td>
<td>29</td>
</tr>
<tr>
<td>Support for school mathematics</td>
<td>Reference to support for mathematics being obtained outside of school</td>
<td>7</td>
<td>20</td>
</tr>
</tbody>
</table>

**Nodes\Framework Categories\Mathematics in Childhood**
Reference to doing or learning mathematics as a child, before, during or outside of primary school.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Sources</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary school experience</td>
<td>Reference to experience of mathematics at primary school</td>
<td>17</td>
<td>44</td>
</tr>
<tr>
<td>Standing up</td>
<td>Reference to the student standing up to do or answer a mathematics problem</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Support for school mathematics</td>
<td>Reference to support for mathematics being obtained outside of school</td>
<td>7</td>
<td>20</td>
</tr>
<tr>
<td>Times tables</td>
<td>Reference to doing times tables</td>
<td>10</td>
<td>18</td>
</tr>
</tbody>
</table>

**Nodes\Framework Categories\Mathematics in the Student's Future**
Reference to the student's beliefs about the significance of mathematics in their future life or career.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Sources</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics as important</td>
<td>Reference to mathematics as being important</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>Mathematics in the future</td>
<td>Reference to the student seeing mathematics as part of their future career</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>Mathematics to move on in life</td>
<td>Reference to mathematics being significant to advance in life</td>
<td>6</td>
<td>11</td>
</tr>
</tbody>
</table>

**Nodes\Framework Categories\Personal Theme**
Reference to the student's personal theme or characterisation of mathematics, depicting what mathematics means to them or how they view mathematics.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Sources</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>A means to an end</td>
<td>In vivo code: Reference to student's feeling about mathematics result in Leaving Certificate</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
### Personal Theme or Characterisation of Mathematics
Reference to students' individual theme or characterisation of mathematics in their lives

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Sources</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Theme or Characterisation of Mathematics</td>
<td>Reference to students' individual theme or characterisation of mathematics in their lives</td>
<td>20</td>
<td>33</td>
</tr>
</tbody>
</table>

### Nodes\ Framework Categories\ Significant People
Reference to the significance of individuals that have been or are currently influential in the student engagement (or not) with mathematics.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Sources</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access officer</td>
<td>Reference to access officer</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Competition</td>
<td>Reference to where there was an element of competition in terms of doing or achieving in mathematics</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Extended family</td>
<td>Reference to member of the extended family and their ability in mathematics</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Father</td>
<td>Reference to the student's father and doing or learning mathematics</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Friends</td>
<td>Reference to student's friend and their engagement with or attitude to mathematics</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>In public</td>
<td>Reference to doing mathematics in a public context, i.e. in class, in front of the teacher and classmates</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Lack of direction</td>
<td>Reference to the student feeling there is a lack of direction in the mathematics instruction given</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Mother</td>
<td>Reference to the student's mother</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Other people's expectation</td>
<td>Reference to other people's expectation of the student regarding their ability or performance in mathematics</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>Parents</td>
<td>Reference to the significance of parents in student's engagement (or not) with mathematics</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Partner</td>
<td>Reference to the student's partner</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Peers</td>
<td>Reference to the influence of peers in the student's approach to mathematics</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>Role of Teacher</td>
<td>Reference to the significance of the teacher to the teaching and learning of mathematics</td>
<td>11</td>
<td>27</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Sources</td>
<td>Reference</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td>Respect for teacher</td>
<td>Reference to the student having or not having respect for a teacher</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Teacher approach or methods</td>
<td>Reference to the approach or methods used by the teacher in mathematics class</td>
<td>19</td>
<td>115</td>
</tr>
<tr>
<td>Teacher support</td>
<td>Reference to school teacher helping with mathematics</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td>Siblings</td>
<td>Reference to the student’s siblings</td>
<td>10</td>
<td>21</td>
</tr>
<tr>
<td>Those good at mathematics</td>
<td>Reference to others whom the student observed as being good at mathematics</td>
<td>4</td>
<td>10</td>
</tr>
</tbody>
</table>

**Nodes\ Framework Categories\Strategy for Mathematics**
Reference to the strategy or strategies the student uses or has used to learn and achieve in mathematics.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Sources</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approach to doing mathematics</td>
<td>Reference to the ways in which the student approached mathematics</td>
<td>17</td>
<td>103</td>
</tr>
<tr>
<td>Strategy</td>
<td>Reference to strategy the student has used to learn and or get through mathematics at school and third level</td>
<td>17</td>
<td>40</td>
</tr>
</tbody>
</table>

**Nodes\ Framework Categories\The Role of Mathematics in Returning to Third Level**
Reference to the student's consideration of mathematics in their decision to enter third level education as a mature student.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Sources</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness of mathematics content</td>
<td>Reference to being aware of mathematics content in third level programme of study</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>Deferral</td>
<td>Reference to deferral of a programme of study</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Mathematics to get into third level</td>
<td>Reference to needing mathematics as an entry requirement for a third level programme</td>
<td>13</td>
<td>24</td>
</tr>
<tr>
<td>Preparation for third level service mathematics</td>
<td>Reference to the mature student's mathematics preparation in advance of starting at the HEI</td>
<td>10</td>
<td>22</td>
</tr>
<tr>
<td>Transition to third level mathematics</td>
<td>Reference to third level mathematics modules (service mathematics)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Sources</td>
<td>Reference</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td>Unaware of mathematics</td>
<td>Reference to student being unaware that the prospective programme of study had a mathematics component</td>
<td>7</td>
<td>10</td>
</tr>
</tbody>
</table>

**Initial Open Coding**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Sources</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>A means to an end</td>
<td>Iv-vivo code: Reference to student's feeling about mathematics result in Leaving Certificate</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Ability</td>
<td>Reference to the student's own ability</td>
<td>16</td>
<td>55</td>
</tr>
<tr>
<td>Absence</td>
<td>Reference to student being absent from school/college</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Abstract</td>
<td>Reference to the abstract elements of doing mathematics</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Access officer</td>
<td>Reference to access officer</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Accountancy</td>
<td>Reference to accountancy as a subject</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Accountant for business</td>
<td>Reference to the student relying on an accountant to handle all financial aspects of her business</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Achievement</td>
<td>Reference to the student's achievement in mathematics</td>
<td>16</td>
<td>32</td>
</tr>
<tr>
<td>Algebra</td>
<td>Reference to the subject algebra</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td>Annoyed</td>
<td>Reference at being annoyed at not being able to do the mathematics</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Anxiety</td>
<td>Reference to anxiety in the context of mathematics and/or dealing with numbers, either in an academic or non-academic environment</td>
<td>14</td>
<td>38</td>
</tr>
<tr>
<td>Appreciation of mathematics</td>
<td>Reference to student having an appreciation of mathematics</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Approach to doing mathematics</td>
<td>Reference to the ways in which the student approached mathematics</td>
<td>17</td>
<td>102</td>
</tr>
<tr>
<td>Aptitude for mathematics</td>
<td>Reference to the student having an aptitude for mathematics</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Arithmetic</td>
<td>Reference to student doing arithmetic</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Sources</td>
<td>References</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
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<td>------------</td>
</tr>
<tr>
<td>Asking questions</td>
<td>Reference to student asking questions about mathematics</td>
<td>9</td>
<td>21</td>
</tr>
<tr>
<td>Attendance</td>
<td>Reference to the student's attendance at mathematics class and school</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Attention to detail</td>
<td>Reference to the student paying attention to detail in respect of mathematics</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Avoidance</td>
<td>Reference to the student avoiding mathematics</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>Awareness of mathematics content</td>
<td>Reference to being aware of mathematics content in third level programme of study</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>Bio</td>
<td>Reference to the student's personal life: upbringing, post school and current</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>Blame</td>
<td>Reference to the student blaming someone for their inability in mathematics or dislike of mathematics</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Blank</td>
<td>Reference to the student going blank when doing or asked to do mathematics</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Boredom</td>
<td>Reference to student being bored in mathematics class</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Calculator</td>
<td>Reference to the use of a calculator to do mathematics</td>
<td>9</td>
<td>28</td>
</tr>
<tr>
<td>Calculus</td>
<td>Reference to the subject of calculus as being an issue for the student</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Calm oneself down</td>
<td>Reference to student efforts to calm themselves down in a situation involving mathematics</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Came back to haunt me</td>
<td>Iv-vivo reference to the effect of school mathematics on student at third level</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Cautious</td>
<td>Reference to the student being cautious doing mathematics</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Challenge</td>
<td>Reference to mathematics being a challenge</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Changed schools</td>
<td>Reference to the student having changed schools</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Clarity in mathematics</td>
<td>Reference to method of doing mathematics being clear and result of doing mathematics problem being clear</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Class duration</td>
<td>Reference to duration of mathematics class</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Sources</td>
<td>References</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------</td>
<td>------------</td>
</tr>
<tr>
<td>Class size</td>
<td>Reference to the number of students in the class</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Classroom</td>
<td>Reference to the class room where mathematics class (class, lecture, tutorial) is held</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Comfortable with mathematics</td>
<td>Reference to the student feeling comfortable with mathematics</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>Communication</td>
<td>Reference to communication being an issue with the teaching or learning of mathematics</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Competition</td>
<td>Reference to where there was an element of competition in terms of doing or achieving in mathematics</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Computer</td>
<td>Reference to using the computer for mathematics</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Confident</td>
<td>Reference to the student’s confidence or lack of confidence in mathematics</td>
<td>11</td>
<td>24</td>
</tr>
<tr>
<td>Confusion</td>
<td>Reference to mathematics being confusing for the student</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Coping</td>
<td>Reference to the student coping in a mathematics environment</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Counting</td>
<td>Reference to counting</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Darts</td>
<td>Reference to the student using calculations in the game of darts</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Deferral</td>
<td>Reference to deferral of a programme of study</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Development</td>
<td>Reference to student’s mathematics development</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Difference between IoT and Uni</td>
<td>Reference to there being a difference between how something is in the IoT and the Uni</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Disappointment</td>
<td>Reference to the student being disappointed about mathematics performance</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Dread</td>
<td>Reference to feelings of dread towards mathematics</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Effort</td>
<td>Reference to the effort made by the student at mathematics</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>Embarrassing</td>
<td>Reference to student being embarrassed in respect of mathematics</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Sources</td>
<td>References</td>
</tr>
<tr>
<td>--------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>---------</td>
<td>------------</td>
</tr>
<tr>
<td>Empathy</td>
<td>Reference to student needing empathy</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Emphasis on passing</td>
<td>Reference to the need to get a pass overall in a mathematics module</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>Engagement</td>
<td>Reference to engagement or non-engagement with mathematics either in an academic or non-academic environment</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>Reference to the student enjoying mathematics</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Enthusiasm</td>
<td>Reference to a person's enthusiasm about mathematics</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Equations</td>
<td>Reference to the student doing mathematics problems involving equations</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Estimation</td>
<td>Reference to student using estimation in mathematics’ problem-solving</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Every Day Mathematics</td>
<td>Reference to the student using mathematics in daily life</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Examinations</td>
<td>Reference to the examinations in mathematics taken or to be taken by the student</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>Excitement</td>
<td>Reference to the student being excited about mathematics</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Extended family</td>
<td>Reference to member of the extended family and their ability in mathematics</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Extra intelligence</td>
<td>Reference to student description of the disparity in knowledge between different students in the class</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Failure</td>
<td>Reference of failure in mathematics, either actual or expected</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Fall behind</td>
<td>Reference to the student falling behind in terms of progress with mathematics</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Father</td>
<td>Reference to the student's father and doing or learning mathematics</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Favourite subject</td>
<td>Reference to mathematics being a favourite subject of the student</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fear</td>
<td>Reference to the student being fearful of doing mathematics</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Sources</td>
<td>References</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------</td>
<td>------------</td>
</tr>
<tr>
<td>Feeling</td>
<td>Reference to how mathematics made the respondent feel</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Fingers</td>
<td>Reference to the student counting on their fingers</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Foreign Language</td>
<td>Iv-vivo code referring to student’s opinion of mathematics as a foreign language</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Forget</td>
<td>Reference to forgetting aspects of mathematics</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Formula</td>
<td>Reference to the student using formulas</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Fractions</td>
<td>Reference to student doing fractions</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Friends</td>
<td>Reference to student’s friend and their engagement with or attitude to mathematics</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Frustration</td>
<td>Reference to the student being frustrated with mathematics</td>
<td>8</td>
<td>24</td>
</tr>
<tr>
<td>Fun</td>
<td>Reference to mathematics being fun</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Funding</td>
<td>Reference to funding impacting on assess to mathematics support</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Geometry</td>
<td>Reference to student doing geometry</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Get a rhythm going</td>
<td>In-vivo reference to doing times tables</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Get it</td>
<td>Reference to the student ‘getting it’ in respect of the mathematics content or solving a mathematics problem</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Getting the right answer</td>
<td>Reference to the emphasis being on getting the right answer</td>
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<td>Good at mathematics</td>
<td>Reference to either the student or another person being good at mathematics</td>
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<td>Hands up</td>
<td>Reference to putting up one’s hand in class</td>
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<td>Hierarchy of mathematics</td>
<td>Iv-vivo reference to the significance of mathematics to the student</td>
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<td>Homework</td>
<td>Reference to doing mathematics homework</td>
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<td>Horrible</td>
<td>Reference to mathematics as (looking) horrible</td>
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<td>Impact of problem with mathematics</td>
<td>Reference to where the problem the student has with mathematics has an impact on aspects of their life.</td>
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<td>Improvement</td>
<td>Reference to the student’s ability in mathematics improving</td>
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<td>In public</td>
<td>Reference to doing mathematics in a public context, i.e. in class, in front of the teacher and classmates</td>
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<td>Incentive to do mathematics</td>
<td>Reference to student receiving an incentive for doing mathematics</td>
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<td>Indices</td>
<td>Reference to the subject of indices and the student’s engagement with it</td>
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<td>Individual attention</td>
<td>Reference to the student receiving individual attention from the teacher</td>
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<td>Information technology</td>
<td>Reference to the use of information technology in learning mathematics</td>
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<td>Interest in mathematics</td>
<td>Reference to student having an interest or not in mathematics</td>
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<td>Intimidation</td>
<td>Reference to the student being intimidated</td>
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<td>Keeping up</td>
<td>In-vivo reference to student being able to keep up with the rest of the class</td>
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<td>Khan Academy</td>
<td>Reference to the online resource Khan Academy</td>
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<td>Lack of direction</td>
<td>Reference to the student feeling there is a lack of direction in the mathematics instruction given</td>
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<td>Learning off</td>
<td>Reference to the student learning off the mathematics content</td>
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<td>Leaving Certificate</td>
<td>Reference to the Leaving Certificate syllabus and/or examination</td>
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<td>Like mathematics</td>
<td>Reference to the student liking or disliking mathematics</td>
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<td>Logarithm</td>
<td>Reference to the use of logarithms</td>
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<td>Looking silly or stupid</td>
<td>Reference to the student feeling that they would look silly or stupid asking for help with mathematics or asking a question about mathematics</td>
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<td>Lost</td>
<td>Reference to student being lost with mathematics</td>
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<td>Love mathematics</td>
<td>Reference to the interviewee loving mathematics</td>
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<td>Luck</td>
<td>Reference to the student's success in mathematics being attributable to luck</td>
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<td>Make sense</td>
<td>Reference to the mathematics making sense to the student</td>
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<td>Mathematics after schooling</td>
<td>Reference to engagement with mathematics after the mature student had completed schooling.</td>
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<td>Mathematics as difficult</td>
<td>Reference to mathematics being difficult</td>
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<td>Mathematics as important</td>
<td>Reference to mathematics as being important</td>
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<td>Mathematics as practical and logical</td>
<td>Reference to mathematics as a practical and logical subject</td>
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<td>Mathematics as riddles or puzzles</td>
<td>Reference to mathematics as riddles or puzzles</td>
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<td>Mathematics at third level - Service Mathematics</td>
<td>Reference to the mathematics modules the student is doing at third level</td>
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<td>Mathematics examinations</td>
<td>Reference to examinations or tests taken by the student</td>
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<td>Mathematics explained using simple English</td>
<td>Reference to mathematics explained using simple English</td>
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<td>Mathematics in disguise</td>
<td>Reference to mathematics being disguised in another subject</td>
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<td>Mathematics in the future</td>
<td>Reference to the student seeing mathematics as part of their future career</td>
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<td>Mathematics problems as words</td>
<td>Reference to the presentation of mathematics problems in word format</td>
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<td>Mathematics to get into third level</td>
<td>Reference to needing mathematics as an entry requirement for a third level programme</td>
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<td>Mathematics to move on in life</td>
<td>Reference to mathematics being significant to advance in life</td>
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<tr>
<td>Mature Student</td>
<td>Reference to issues specific to mature students, including family life, work-life balance, family commitments, financial challenges</td>
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<td>Mature Student vs. Traditional Student</td>
<td>Reference to situations where the mature student is compared to the traditional students within their cohort</td>
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<td>Mature Student's Children and mathematics</td>
<td>Reference to the mature student's child(ren) and their engagement with mathematics</td>
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<td>Mental arithmetic</td>
<td>Reference to doing mental arithmetic</td>
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<td>Messing</td>
<td>Reference to student misbehaviour or 'messing' in class</td>
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<td>Mnemonics</td>
<td>Reference to the use of mnemonics to assist with learning mathematics</td>
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<td>Mother</td>
<td>Reference to the student's mother</td>
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<td>Nervous</td>
<td>Reference to the student feeling nervous about mathematics</td>
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<td>No way of knowing</td>
<td>Reference to the student not knowing if they have done the mathematics problem correctly</td>
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<td>Nothing to do with mathematics</td>
<td>Reference to the student believing a programme had 'nothing to do with mathematics'</td>
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<td>Other people's expectation</td>
<td>Reference to other people's expectation of the student regarding their ability or performance in mathematics</td>
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<td>Pace of class</td>
<td>Reference to pace of mathematics class at school</td>
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<td>Pace of third level class</td>
<td>Reference to the pace of mathematics classes at third level, lectures and tutorials</td>
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<td>Panic</td>
<td>Reference to the student panicking about mathematics</td>
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<td>Parents</td>
<td>Reference to the significance of parents in student's engagement (or not) with mathematics</td>
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<td>Partner</td>
<td>Reference to the student's partner</td>
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<td>Pattern</td>
<td>Reference to seeing a pattern in mathematics work</td>
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<td>Peers</td>
<td>Reference to the influence of peers in the student's approach to mathematics</td>
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<td>Perseverance</td>
<td>Reference to student persevering with their mathematics</td>
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<td>Personal Theme or Characterisation of Mathematics</td>
<td>Reference to students' individual theme or characterisation of mathematics in their lives</td>
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<td>Physical symptoms</td>
<td>Reference to student experiencing physical symptoms as a result of engaging with mathematics</td>
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<td>Practical mathematics</td>
<td>Reference to mathematics that is used in everyday or real life contexts</td>
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<td>Preparation</td>
<td>Reference to student being prepared for mathematics</td>
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<td>Preparation for third level service mathematics</td>
<td>Reference to the mature student's mathematics preparation in advance of starting at the HEI</td>
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<td>Pressure</td>
<td>Reference to the student feeling under pressure in a mathematics situation</td>
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<td>Primary school experience</td>
<td>Reference to experience of mathematics at primary school</td>
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<td>Problem-solving</td>
<td>Reference to doing problem solving in mathematics</td>
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<td>Punishment</td>
<td>Reference to punishment in respect of doing mathematics</td>
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<td>Reading mathematics</td>
<td>Reference to reading mathematics either in an academic or non-academic environment</td>
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<td>Red flag</td>
<td>In-vivo reference to mathematics in the programme being like a red flag</td>
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<td>Regret</td>
<td>Reference to student feeling regret</td>
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<td>Relevance</td>
<td>Reference to the relevance of mathematics</td>
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<td>Remembering mathematics</td>
<td>Reference to the student talking about remembering mathematics</td>
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<td>Respect for teacher</td>
<td>Reference to the student having or not having respect for a teacher</td>
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<td>Retention of mathematics from school</td>
<td>Reference to student's retention - or not - of school mathematics</td>
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<td>Role of Teacher</td>
<td>Reference to the significance of the teacher to the teaching and learning of mathematics</td>
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<td>Scarred for life</td>
<td>Iv-vivo code referring to the impact failure in mathematics had on their subsequent approach to mathematics</td>
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<td>Scary and daunting</td>
<td>Iv-vivo reference to how the student felt about mathematics</td>
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<td>Scribe</td>
<td>Reference to the student having access to a scribe to assist with examinations</td>
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<td>Secondary school experience</td>
<td>Reference to experience of doing mathematics at secondary school</td>
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<td>Self-confidence</td>
<td>Reference to student's self-confidence</td>
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<td>Reference to the student being critical of him/herself</td>
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<td>Self-doubt</td>
<td>Reference to the student experiencing self-doubt</td>
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<td>In-vivo reference to the student's feeling about the amount of mathematics in the programme of study</td>
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<td>Short term memory</td>
<td>Reference to the use of short term memory in studying mathematics for examinations or tests</td>
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<td>Reference to the student's siblings</td>
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<td>Slowing down the class</td>
<td>Reference to the student slowing down the class because of their inability with mathematics</td>
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<td>Social context</td>
<td>Reference to the social context for the student</td>
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<td>Standard deviation</td>
<td>Reference to the student doing standard deviation in statistics</td>
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<td>Standing up</td>
<td>Reference to the student standing up to do or answer a mathematics problem</td>
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<td>Statistics</td>
<td>Contains Reference to statistics as a mathematical subject or statistics in everyday life</td>
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<td>Step-by-step</td>
<td>Reference to student approaching mathematics step-by-step</td>
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<td>Strategy</td>
<td>Reference to strategy the student has used to learn and or get through mathematics at school and third level</td>
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<td>Streaming</td>
<td>Reference to streaming of students into different class groups</td>
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<td>Reference to the student struggling with mathematics</td>
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<td>Reference to the student engaging with subtraction as a mathematical operation</td>
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<td>Reference to the student saying they suffered because of mathematics</td>
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<td>Support for school mathematics</td>
<td>Reference to support for mathematics being obtained outside of school</td>
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<td>Support in or outside HEI</td>
<td>Reference to support with mathematics as provided to the student by another individual</td>
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<td>Symbols</td>
<td>Reference to mathematical symbols</td>
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<td>Take it personally</td>
<td>Reference to student taking something personally</td>
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<td>Taking notes</td>
<td>Reference to taking notes in mathematics classes or lectures - in a helpful sense</td>
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<td>Teacher approach or methods</td>
<td>Reference to the approach or methods used by the teacher in mathematics class</td>
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<td>Teacher support</td>
<td>Reference to school teacher helping with mathematics</td>
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<td>Terminology</td>
<td>Reference to the terminology used to talk about mathematics</td>
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<td>Terrified</td>
<td>Reference to student feeling terrified in mathematics class</td>
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<td>Textbook</td>
<td>Reference to the use of a text book (at any level - primary, post-primary, third level)</td>
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<td>The Maths Factor</td>
<td>In-vivo code describing the student's view of mathematics</td>
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<td>Those good at mathematics</td>
<td>Reference to others whom the student observed as being good at mathematics</td>
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<td>Throwing mathematics book across the floor</td>
<td>Reference to student's reaction to being frustrated with mathematics</td>
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<td>Time away from mathematics</td>
<td>Reference to student not having done mathematics in years, or since school</td>
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<td>Time to do mathematics</td>
<td>Reference to the time required to do mathematics</td>
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<td>Times tables</td>
<td>Reference to doing times tables</td>
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<td>Tools and resources</td>
<td>Reference to the use of tools or resources to aid student learning</td>
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<td>Reference to third level mathematics modules (service mathematics)</td>
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<td>Trigonometry</td>
<td>Reference to the student doing trigonometry</td>
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<td>Turning point</td>
<td>Reference to an incident when the student realised they didn't like mathematics</td>
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<td>Tutorials</td>
<td>Reference to tutorials at third level</td>
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<td>Unaware of mathematics content</td>
<td>Reference to student being unaware that the prospective programme of study had a mathematics component</td>
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<td>Uncomfortable</td>
<td>Reference to the student being uncomfortable with mathematics</td>
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<td>Understanding</td>
<td>Reference to students understanding mathematics</td>
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<td>Upset</td>
<td>Reference to student being upset about mathematics</td>
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<td>Value of mathematics</td>
<td>Reference to the value of mathematics as a subject</td>
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<td>Verbal abuse</td>
<td>Reference to the teacher using verbal abuse toward the student</td>
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<td>Visualise mathematics</td>
<td>Reference to visualising mathematics or mathematics problems</td>
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<td>Work out mathematics in my head</td>
<td>Reference to the student solving problems - or trying to - in his/her head</td>
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<td>Worry</td>
<td>Contains Reference to worrying in respect of dealing with maths</td>
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</tr>
<tr>
<td>YouTube</td>
<td>Reference to the student using YouTube to help with mathematics understanding</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
Appendix P Application for Ethical Approval for Research
Faculty of Science and Engineering Ethics Committee
Expedited Form for research involving human participants

1: Applicant’s Details

| Principal Investigator name (ie supervisor): Dr. Olivia Fitzmaurice |
| Principal Investigator email: Olivia.Fitzmaurice@ul.ie |
| Student name: Maria Ryan |
| ID number: 9216669 |
| Email address: maria.ryan@ul.ie |
| Programme of study: Structured Ph.D. (Education) |
| FYP, MSc or Ph.D. Dissertation: Ph.D. Dissertation |
| Working title of study: The Effect of Mathematics Anxiety among Mature Students learning Service Mathematics in Ireland |
| Period for which approval is sought: Start Date: 01/08/15 End date: 31/10/16 |

2. Human Participants

Does the research proposal involve:

- Working with participants over 65 years of age? ☐ No ☐
- Any person under the age of 18? ☐ No ☐
- Adult patients? ☐ No ☐
- Adults with psychological impairments? ☐ No ☐
- Adults with learning difficulties? ☐ No ☐
- Adults under the protection/control/influence of others (e.g. in care/prison)? ☐ No ☐
- Relatives of ill people (e.g. parents of sick children) ☐ No ☐
- People who may only have a basic knowledge of English? ☐ No ☐
- Hospital or GP patients (or HSE members of staff) recruited in medical facility ☐ No ☐

3. Subject Matter

Does the research proposal involve:

- Sensitive personal issues? (e.g. suicide, bereavement, gender identity, sexuality, fertility, abortion, gambling)? ☐ No ☐
- Illegal activities, illicit drug taking, substance abuse or the self reporting of criminal behaviour? ☐ No ☐
- Any act that might diminish self-respect or cause shame, embarrassment or regret? ☐ No ☐
- Research into politically and/or racially/ethnically and/or commercially sensitive areas? ☐ No ☐

4. Procedures

Does the research proposal involve:

- Use of personal records without consent? ☐ No ☐
- Deception of participants? ☐ No ☐
- The offer of large inducements to participate? ☐ No ☐
- Audio or visual recording without consent? ☐ No ☐
- Invasive physical interventions or treatments? ☐ No ☐
- Research that might put researchers or participants at risk? ☐ No ☐
- Storage of results data for less than 7 years? ☐ No ☐

If you have answered Yes to any of these questions in sections 2 to 4 above, you will need to fill in the ULREC application form and submit to the Faculty Ethics Committee for review. However, if the research is to be conducted during teaching practice, and within the
5 Research Project Information

5a Give a brief description of the research.

The aim of the research is to explore the effect of mathematics anxiety among mature students who learn service mathematics. In order to facilitate this aim, it is necessary to address the following research questions:

1. To what extent does maths anxiety exist among mature students studying service maths at 3rd level in Ireland?
2. To what extent do present encounters with maths trigger Maths Anxiety?
3. To what extent do specific incidents in a mature student's life history give rise to the Maths Anxiety that these students experience?
4. What coping mechanisms do these mature students use to deal with their Maths Anxiety?

This study will comprise 2 Phases: Phase One - Mathematics Anxiety Scale questionnaire, and Phase Two – semi-structured interviews. Phase One comprises a quantitative study and will commence in August 2015 with the distribution of a questionnaire (Appendix 1) to full-time undergraduate mature students in a range of higher education institutions (HEIs) who study service mathematics as part of their degree. I envisage that the analysis of the data will present findings relating to the prevalence of negative attitudes towards mathematics among mature students, which will be explored further in Phase Two of the research.

Phase Two comprises a qualitative study and will take place late 2015/early 2016 with the conducting of one-to-one semi-structured interviews with a selection of 6-10 participants from Phase One (list of indicative questions attached - Appendix 2).

5b How many participants will be involved?

During Phase one, I intend to target all mature students learning service mathematics in each of the HEIs. During Phase two I intend interviewing 6-10 participants who completed Phase one, and – through their questionnaire responses – have exhibited varying levels of mathematics anxiety.

5c How do you plan to gain access to /contact/approach potential participants?

Phase one: I will liaise with Mature Student Officers in the HEIs and request their cooperation in the distribution of the questionnaire. With the colleagues’ cooperation, I will meet the target groups of students in a plenary session (i.e. a lecture theatre after a service maths lecture) and inform them of my intention to conduct the research, and prompt students to ask questions about the research; I will distribute to students an Information Sheet on the study (attached) and a Consent Form (attached), along with the questionnaire, and provide students with the opportunity to complete the questionnaires at that time.
**Phase two:** I will identify a selection of students who participated in Phase one to participate in Phase two and invite them by phone/text message/email to meet me for a semi-structured interview at an appropriate date, time and location.

<table>
<thead>
<tr>
<th>5d</th>
<th>What are the criteria for including/excluding individuals from the study?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Participants must be mature students enrolled at the HEI in a full-time undergraduate programme which has a service mathematics component, i.e. participants must be aged 23 years or over, but not aged over 65.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5e</th>
<th>Have arrangements been made to accommodate individuals who do not wish to participate in the research? (NB This mainly relates to research taking place in a classroom setting)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N/A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5f</th>
<th>Can you identify any particular vulnerability of your participants other than those mentioned in section 2?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5g</th>
<th>Where will the study take place?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Phase one will take place at the respective HEIs in a pre-booked lecture hall. Phase two will take place at the respective HEI in an agreed location that is conducive to preserving the confidentiality and anonymity of the participant and allowing the audio recording of the interview. This will be arranged in advance in collaboration with the relevant HEI.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5h</th>
<th>What arrangements have you made for anonymity and confidentiality?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All information gathered will remain confidential and used only for the purpose of this study. The questionnaire in Phase 1 may be completed anonymously, i.e. without the need to provide the student’s name or contact details. During Phase one, students will be asked to indicate if they wish to be considered for participation in Phase two. Where this is the case, these students will be required to submit their email address or contact phone number to allow correspondence from myself. Where students do not express a willingness to participate in Phase two, their completed questionnaires will be assigned a code for the purpose of identification. In Phase two, all references to the participants’ identities within the interview transcripts will be anonymised. Pseudonyms will be used with the permission of the participant. Participants will be advised from the outset – in the Information sheet – that the information provided both in the questionnaire and the interview will only be used within the context of this research study. The information will not be used in any way that would reveal participants’ identities or disclose the responses to the questions as belonging to the participants.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5i</th>
<th>What are the safety issues (if any) arising from this study, and how will you deal with them?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>There are no perceived safety issues; however, in the event that a participant feels uncertain in this regard, they are free to withdraw from the study at any time.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5j</th>
<th>How do you propose to store the information once the project is completed? Will the file/computer be password protected?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
All questionnaires will be stored in the Principal Investigator’s office in a locked cabinet. A separate record of codes assigned to questionnaires and their corresponding email addresses/phone numbers will be stored in a locked cabinet in the Principal Investigator’s office.

Interview transcripts will be assigned the same code as the corresponding questionnaires for comparison purposes. The printed transcripts and questionnaires will be stored in a locked cabinet in the Principal Investigator’s office, separate to the location of the code and email details.

Digital files, i.e. the audio-recordings of the interviews and the interview transcripts, will be saved on a password protected memory stick and stored separately to the corresponding documentation in the Principal Investigator’s office in a locked cabinet. All information will be stored for 7 years, i.e. until June 2023.

**Where will the information be stored (room number):**
The office of the Principal Investigator (D2-036)

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**5k Insurance Cover**

Insurance cover is required for all research carried out by UL employees. Principal Investigators/Supervisors should carefully view the University’s ‘Guidelines on Insurance Cover for Research’ document and the University’s Insurance cover to ascertain if their proposed research is covered. These documents are available at www.ul.ie/insurance.

Where any query arises about whether or not proposed research is covered by insurance, the Principal Investigator/Supervisor must contact the University’s Insurance Administrator at cliona.donnellan@ul.ie to confirm that the required level of insurance cover is in place.

Please indicate by way of signature that the research project is covered by UL’s insurance policies:

PI/Supervisor signature: ________________________________

---

**5l Please attach the relevant information documents and complete the following checklist to indicate which documents are included with application**

<table>
<thead>
<tr>
<th>Document</th>
<th>Included</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant Information Sheet</td>
<td>Yes</td>
</tr>
<tr>
<td>Participant Informed Consent Form</td>
<td>Yes</td>
</tr>
<tr>
<td>Parent/Guardian Information Sheet</td>
<td>No</td>
</tr>
<tr>
<td>Parent/Guardian Informed Consent Form</td>
<td>No</td>
</tr>
<tr>
<td>School Principal Information Sheet</td>
<td>No</td>
</tr>
<tr>
<td>School Principal Informed Consent Form</td>
<td>No</td>
</tr>
<tr>
<td>Teacher Information Sheet</td>
<td>No</td>
</tr>
<tr>
<td>Teacher Consent Form</td>
<td>No</td>
</tr>
<tr>
<td>Child Protection Form</td>
<td>No</td>
</tr>
<tr>
<td>Questionnaire &amp; Explanatory Cover Letter</td>
<td>Yes</td>
</tr>
<tr>
<td>Interview/Survey Questions</td>
<td>Yes</td>
</tr>
<tr>
<td>Recruitment letters/Advertisements/Emails, etc.</td>
<td>No</td>
</tr>
</tbody>
</table>

---

**6. Declaration**

The information in this form is accurate to the best of my knowledge and belief and I take full responsibility for it.

I undertake to abide by the guidelines outlined in the UL Research Ethics Committee guidelines [http://www.ul.ie/researchethics/](http://www.ul.ie/researchethics/)
I undertake to inform S&EEC of any changes to the study from those detailed in this application.

<table>
<thead>
<tr>
<th>Student:</th>
<th>Name: Maria Ryan</th>
<th>Date: 23/01/2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signature:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Principal Investigator*:</th>
<th>Name:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signature:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* In the case where the principal investigator is not a permanent employee of the University, the relevant head of department must sign this declaration in their place.

You should return this form with signatures to the S&E Ethics Committee c/o Faculty Office, Faculty of Science & Engineering, University of Limerick. In addition, a single pdf file containing the completed form and additional information (e.g. participant information sheet) should be emailed to SciEngEthics@ul.ie This form must be submitted and approval granted before the study begins.
Appendix Q Email Correspondence with Ethics Committee clarifying Two Components of Ethics Application
(presented in reverse chronological order)

From: Eileen.Madden
Sent: 20 February 2015 15:20
To: Maria.Ryan; Olivia.Fitzmaurice
Cc: Eileen.Madden
Subject: RE: Ethics Decision. Ref: 2015_02_03

Thanks Maria
Full approval has been granted for your project.
Regards
Eileen

From: Maria.Ryan
Sent: 20 February 2015 13:27
To: Eileen.Madden; Olivia.Fitzmaurice
Subject: RE: Ethics Decision. Ref: 2015_02_03

Eileen,
thank you for your email. In response to the queries listed:
5c: I will not be teaching any of the students asked to participate in the study.
5j: I would like to hereby confirm that all audio recordings will be destroyed once they have been transcribed.
I hope this is satisfactory clarification of these issues.
With kind regards,
Maria

From: Eileen.Madden
Sent: 19 February 2015 13:16
To: Olivia.Fitzmaurice; Maria.Ryan
Cc: Eileen.Madden
Subject: Ethics Decision. Ref: 2015_02_03

The Ethics Committee reviewed your recent application and have raised the issues below, these issues need to be dealt with before final approval can be granted. Please email me with the updated information, there is no need for a hard copy.

2015_02_03_S&E, The Existence of Mathematics Anxiety among mature students learning Service Mathematics in Ireland,
Investigator(s): Olivia Fitzmaurice, Maria Ryan
• 5c Clarification is required as to whether the investigator is teaching the students who will be asked to participate in the study
• 5j Mention needs to be made that audio recordings will be destroyed once they have been transcribed

Eileen Madden
Riarthóir Dáimhe/Faculty Administrator
Dámh na hEolafochta agus na hInnealtóireachta/Faculty of Science & Engineering
Ollscoil Luinnigh/University of Limerick
Appendix R Email Correspondence with Ethics Committee about Request to audio-record Skype Interview
(presented in reverse chronological order)

From: Maria.Ryan
Sent: 16 March 2016 15:45
To: Eileen.Madden
Subject: RE: Further update to ethics submission

Thank you, Eileen, that is the case. The interviewee is informed in advance that the conversation will be audio-recorded.

Kind regards,
Maria

From: Eileen.Madden
Sent: 16 March 2016 15:35
To: Maria.Ryan
Cc: Eileen.Madden
Subject: RE: Further update to ethics submission

Hi Maria
This is fine as long as it is only audio and that the participant is made aware of it.
Regards
Eileen

From: Maria.Ryan
Sent: 16 March 2016 14:38
To: Eileen.Madden
Subject: Further update to ethics submission

Good afternoon, Eileen,

I am about to start the data collection phase of my Ph.D. research, and am considering the prospect of conducting interviews by Skype, in the event that a student cannot meet me face-to-face. This would mean audio recording the Skype conversation using a digital recording device like what I would use in a face-to-face interview.

Can you please advise, Eileen, if this is acceptable by the Ethics Committee, and if I need to resubmit my application? My application number and details are below:

2015_02_03_S&E, The Existence of Mathematics Anxiety among mature students learning Service Mathematics in Ireland,
Investigator(s): Olivia Fitzmaurice, Maria Ryan

With kind regards,
Maria Ryan
Student ID: 9216669
## Appendix S Table of Non-significant Correlations

### Complete MAS-UK Correlations

<table>
<thead>
<tr>
<th>Correlation</th>
<th>r</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age and MAS-UK Score</td>
<td>-0.014</td>
<td>0.888</td>
</tr>
<tr>
<td>Age and Rating of Ability in Mathematics Today</td>
<td>-0.047</td>
<td>0.631</td>
</tr>
<tr>
<td>Years Since Left School and Rating of Ability in Mathematics</td>
<td>-0.057</td>
<td>0.563</td>
</tr>
<tr>
<td>Years Since Left School and Awareness of Mathematics Support service</td>
<td>-0.023</td>
<td>0.813</td>
</tr>
<tr>
<td>Years Since Left School and Intention to use Mathematics Support service</td>
<td>-0.158</td>
<td>0.106</td>
</tr>
</tbody>
</table>

### Factor 1 Correlations

<table>
<thead>
<tr>
<th>Correlation</th>
<th>r</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age and Factor 1 Score</td>
<td>-0.08</td>
<td>0.411</td>
</tr>
<tr>
<td>First Language and Factor 1 Score</td>
<td>-0.149</td>
<td>0.125</td>
</tr>
<tr>
<td>Years Since Left School and Factor 1 Score</td>
<td>-0.060</td>
<td>0.542</td>
</tr>
<tr>
<td>HEI and Factor 1 Score</td>
<td>-0.042</td>
<td>0.668</td>
</tr>
<tr>
<td>Discipline of Study and Factor 1 score</td>
<td>-0.097</td>
<td>0.319</td>
</tr>
<tr>
<td>Level of Programme and Factor 1 score</td>
<td>-0.104</td>
<td>0.285</td>
</tr>
<tr>
<td>Effect of Respondents updating their Mathematics Knowledge and Factor 1 score</td>
<td>0.122</td>
<td>0.211</td>
</tr>
<tr>
<td>Other Programmes of Study Completed and Factor 1 Score</td>
<td>-0.071</td>
<td>0.470</td>
</tr>
<tr>
<td>Intention to use Mathematics Support and Factor 1 Score</td>
<td>0.013</td>
<td>0.892</td>
</tr>
</tbody>
</table>

### Factor 2 Correlations

<table>
<thead>
<tr>
<th>Correlation</th>
<th>r</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender and Factor 2 score</td>
<td>0.058</td>
<td>0.552</td>
</tr>
<tr>
<td>Age and Factor 2 Score</td>
<td>-0.057</td>
<td>0.559</td>
</tr>
<tr>
<td>First Language and Factor 2 Score</td>
<td>0.037</td>
<td>0.704</td>
</tr>
<tr>
<td>Years since leaving School and Factor 2 Score</td>
<td>-0.056</td>
<td>0.569</td>
</tr>
<tr>
<td>HEI and Factor 2 Score</td>
<td>-0.187</td>
<td>0.054</td>
</tr>
<tr>
<td>Discipline of Study and Factor 2 Score</td>
<td>-0.134</td>
<td>0.170</td>
</tr>
<tr>
<td>Effect of Respondents updating their Mathematics Knowledge and Factor 2 score</td>
<td>0.049</td>
<td>0.617</td>
</tr>
<tr>
<td>Other Programmes of Study Completed and Factor 2 Score</td>
<td>-0.114</td>
<td>0.247</td>
</tr>
<tr>
<td>Intention to use Mathematics Support and Factor 2 Score</td>
<td>-0.038</td>
<td>0.695</td>
</tr>
<tr>
<td>Mathematics in Respondents’ Future Careers and Factor 2 score</td>
<td>0.121</td>
<td>0.213</td>
</tr>
</tbody>
</table>

### Factor 3 Correlations

<table>
<thead>
<tr>
<th>Correlation</th>
<th>r</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender and Factor 3 score</td>
<td>0.175</td>
<td>0.071</td>
</tr>
<tr>
<td>Age and Factor 3 Score</td>
<td>0.168</td>
<td>0.089</td>
</tr>
<tr>
<td>First Language and Factor 3 Score</td>
<td>-0.143</td>
<td>0.142</td>
</tr>
<tr>
<td>Years since leaving School and Factor 3 Score</td>
<td>0.177</td>
<td>0.069</td>
</tr>
<tr>
<td>HEI and Factor 3 Score</td>
<td>0.003</td>
<td>0.972</td>
</tr>
<tr>
<td>Discipline of Study and Factor 3 score</td>
<td>-0.033</td>
<td>0.737</td>
</tr>
<tr>
<td>Level of Programme and Factor 3 score</td>
<td>0.099</td>
<td>0.310</td>
</tr>
<tr>
<td>Other Programmes of Study Completed and Factor 3 Score</td>
<td>-0.033</td>
<td>0.736</td>
</tr>
</tbody>
</table>
## Appendix T Model of a Mathematics Anxiety Reaction and Suggested Modifications

<table>
<thead>
<tr>
<th>Environmental Antecedents</th>
<th>Original Factors (Cemen, 1987)</th>
<th>Modified Factors (in bold)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of Parental Encouragement</td>
<td></td>
<td>Parental Encouragement</td>
</tr>
<tr>
<td>- Attempts to help</td>
<td>- Attempts to help</td>
<td></td>
</tr>
<tr>
<td>- Encouragement in belief and worth</td>
<td>- Encouragement in belief and worth</td>
<td></td>
</tr>
<tr>
<td>Negative Experiences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Lack of success in front of Teacher/Parent</td>
<td>- Past experiences – School</td>
<td></td>
</tr>
<tr>
<td>- Embarrassment</td>
<td>- Success (or not) in front of Teacher/Parent</td>
<td></td>
</tr>
<tr>
<td>- Feeling stupid</td>
<td>- Embarrassment</td>
<td></td>
</tr>
<tr>
<td>- Teacher perception of Student’s ability</td>
<td>- Teacher intimidation, feeling stupid</td>
<td></td>
</tr>
<tr>
<td>- Demand for correctness</td>
<td>- Teacher perception of Student’s ability</td>
<td></td>
</tr>
<tr>
<td>- Lack of cognitive and emotional support</td>
<td>- Demand for correctness</td>
<td></td>
</tr>
<tr>
<td>- Reluctant to seek help from Teacher</td>
<td>- Cognitive and emotional support</td>
<td></td>
</tr>
<tr>
<td>- Punishment</td>
<td>- Inclination to seek help from Teacher</td>
<td></td>
</tr>
<tr>
<td>Mathematics achievement below expectation</td>
<td>- Punishment</td>
<td></td>
</tr>
<tr>
<td>- Link between achievement and anxiety</td>
<td>- Past experiences – Work</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dispositional Antecedents</th>
<th>Self-doubt</th>
<th>Extent of self-doubt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perception of being no good at Mathematics</td>
<td>- Perception of ability in mathematics</td>
<td></td>
</tr>
<tr>
<td>Poor study skills/preparation</td>
<td>- Study skills/approach to preparation</td>
<td></td>
</tr>
<tr>
<td>Impact of failure and repeated failure</td>
<td>- Impact of failure and repeated failure</td>
<td></td>
</tr>
<tr>
<td>Lack of confidence</td>
<td>- Confidence</td>
<td></td>
</tr>
<tr>
<td>Attitudes to mathematics</td>
<td>Atitudes to mathematics</td>
<td></td>
</tr>
<tr>
<td>- Perceived usefulness of mathematics</td>
<td>- Perceived usefulness/relevance of mathematics</td>
<td></td>
</tr>
<tr>
<td>- Mathematics as male domain</td>
<td>- Mathematics as male domain</td>
<td></td>
</tr>
<tr>
<td>Sex role/social stereotype</td>
<td>Prior avoidance</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Situational Antecedents</th>
<th>The Nature of Mathematics</th>
<th>The Nature of Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics</td>
<td>- Topics</td>
<td></td>
</tr>
<tr>
<td>Cumulative nature</td>
<td>- Cumulative nature</td>
<td></td>
</tr>
<tr>
<td>Abstractness</td>
<td>- Abstractness</td>
<td></td>
</tr>
<tr>
<td>Exactness/perfection</td>
<td>- Exactness/perfection/one right answer</td>
<td></td>
</tr>
<tr>
<td>Can’t make up for missed work</td>
<td>- Difficulty keeping up</td>
<td></td>
</tr>
<tr>
<td>Classroom factors</td>
<td>- Academic vs. everyday mathematics</td>
<td></td>
</tr>
<tr>
<td>Teacher personality</td>
<td>- Resources</td>
<td></td>
</tr>
<tr>
<td>Class size</td>
<td>Classroom factors</td>
<td></td>
</tr>
<tr>
<td>Time limitation</td>
<td>- Teacher personality</td>
<td></td>
</tr>
<tr>
<td>Public setting</td>
<td>- Class size</td>
<td></td>
</tr>
<tr>
<td>The way mathematics is taught</td>
<td>- Time limitation</td>
<td></td>
</tr>
<tr>
<td>Pace</td>
<td>- Public setting</td>
<td></td>
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<tr>
<td>Teacher methods</td>
<td>- Scheduling of classes</td>
<td></td>
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<tr>
<td>Test anxiety</td>
<td>The way mathematics is taught</td>
<td></td>
</tr>
<tr>
<td>Level of preparation for test</td>
<td>- Pace and cumulative nature</td>
<td></td>
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<tr>
<td>Importance of test</td>
<td>- Duration</td>
<td></td>
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<tr>
<td>Having a time limit</td>
<td>- Teacher methods</td>
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<tr>
<td><strong>Mode of examination</strong></td>
<td>- Presenting context for mathematics</td>
<td></td>
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