AN INVESTIGATION OF THE FACTORS AFFECTING STUDENT MOTIVATION IN JUNIOR CYCLE SCIENCE IN IRELAND

BEULAH MCMANUS

B. Sc. Science with Concurrent Teacher Education (Physics and Chemistry)

Supervisors: Dr. Peter E. Childs and Dr. Teresa Curtin

Department of Chemical and Environmental Sciences, University of Limerick

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ABSTRACT

An Investigation of the Factors Affecting Student Motivation in Junior Cycle Science in Ireland.

This research project involved the investigation of the factors affecting junior cycle science students’ motivation to study science in Ireland. Too many young students are being turned off science too soon. Research has shown that students come into school with strong innate interest in science, but that the decline of their interest results from the way science is taught in schools (Mitchell 1993; Krajcik et al. 2003; Palmer 2009). This research project aimed to discover the main factors that affect students’ motivation to study science at this stage and to discover whether or not disengaged students can reengage with science in school.

The project was split into two phases: a quantitative study and a qualitative study. Findings from both the quantitative and qualitative phases of the study were analysed together using a triangulation approach. The quantitative investigation involved designing two questionnaires: a student questionnaire and a teacher questionnaire. The student questionnaire sought information about the students’ attitudes towards science, the teaching approaches used in their science lessons, their motivation in science and their plans for careers in science. The teacher questionnaire aimed to discover the factors which they perceive to affect their students’ motivation in science.

For the quantitative study, a representative sample of 100 second-level schools were selected from a list of the second-level schools (N=212) in Munster (which is a province in Ireland), using a stratified sampling approach. Three Teacher Questionnaires were sent to each of the 100 schools (N=300). In total, 77 teachers returned the teacher questionnaires from 48 various Munster schools (n= 25.6%). The student questionnaires were administered to 11 schools which showed interest in allowing their students to partake in the study. 1,427 student questionnaires were returned from 10 of the 11 interested schools (N=2330, 61.2% response). SPSS Version 21.0 was used to analyse the responses in the questionnaires.

Phase two of this study, the qualitative phase, involved three teacher interviews with three teachers from one school, and three student focus groups with groups of six 1st year students, six 2nd year students and six 3rd year students in the same co-educational school as the teacher interviews. The interview and focus group questions were devised based on the main themes emerging from the questionnaire data and aspects previously not examined in the questionnaire.

Results from this study reveal that many Irish students are motivated to study science in a typical sense, that is, they appear diligent, hard working and they are interested in learning science for the sake of learning science. Many other students are also motivated however, motivated to show others that they are able to well, motivated to study harder because they want a career that involves science, or because they want to get a good grade. What is clear from the data, is that the latter type of motivation involving performance goals, tends to dominate students’ motivation in learning science. A further interesting finding from this study is that science self-concept is the key factor in reengaging disengaged students in science, where female students in particular experience lower levels of science self-concept than their male counterparts.
DECLARATION

This thesis is presented in fulfilment of the requirements for the degree of Masters in Science. It is entirely my own work and has not been submitted to any other University, Institution of Higher Education, or 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.

Signature: __________________________

Beulah McManus       Nov 2016
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## TABLE OF CONTENTS

**ABSTRACT** 1

**DECLARATION**  II

**ACKNOWLEDGEMENTS**  III

**TABLE OF CONTENTS**  IV

**LIST OF FIGURES**  VII

**LIST OF TABLES**  IX

**Chapter 1: Introduction**  1

1.1 Background to Project 1
1.2 Purpose of this Study 2
1.3 Research Questions 2
1.5 Overview of Chapters 2

**Chapter 2: Literature Review**  4

2.1 Literature Review Introduction 4
2.2 Motivation 4
   2.2.1 Theoretical Frameworks of Motivation 5
   2.2.2 Conclusion 11
2.3 Motivation in Education 11
   2.3.1 Goal Orientations 12
   2.3.2 Learning Environment 16
   2.3.3 Task Value 20
   2.3.4 Self-Efficacy 22
   2.3.5 Conclusion 24
2.4 Motivation in Science Education 25
   2.4.1 Are Students Motivated to Study Science in School? 28
   2.4.2 What Studies Have Been Carried Out on Students’ Motivation in Science? 37
5.2 In What Way do Junior Cycle Science Students’ Motivational Orientations Differ in the First Three Years of Post-Primary Education in Ireland?

5.2.1 First Year Students

5.2.2 Second Year Students

5.2.3 Third Year Students

5.3 What Are the Main Factors that Affect Students’ Motivation in Junior Cycle Science in Ireland?

5.3.1 Goals

5.3.2 Learning Environment

5.3.3 Task Value

5.3.4 Family Background

5.3.5 Gender

5.4 Are Irish Students Motivated to Study Junior Cycle Science in School?

5.5 Conclusion

Chapter 6: Conclusions

6.1 Introduction

6.2 Limitations of the Study

6.3 Directions for Future Work

6.4 Personal Reflection

Bibliography

List of Appendices
LIST OF FIGURES

Figure 2.1: Concept map of the main theories underpinning motivation in education as will be explored in this thesis.................................................................6
Figure 2.2: Trends of the uptake of Leaving Certificate science subjects in Ireland .....30
Figure 2.3: Participation rates of all optional Leaving Certificate subjects in Ireland in 2014. .................................................................31
Figure 2.4: Mean scores on the overall science scale for Ireland, the highest, the lowest and the average across OECD countries in 2006, 2009 and 2012. .........................33
Figure 2.5: Percentage breakdown of 2014 Higher Level Leaving Certificate candidates by grade (source: State Examinations Commission 2014)..................................34
Figure 4.1: Student respondents’ level of agreement with statements relating to how interesting they find science in school (N = 1427).................................102
Figure 4.2: Respondents’ level of agreement with the statement ‘science is important for helping us to understand the world’ and ‘science is a difficult subject’ (N =1427). ....104
Figure 4.3: Respondents’ level of agreement with items related to ‘career aspirations in science’ (N = 1427). ..............................................................................107
Figure 4.4: Mean values of overall motivation orientation scales (N = 1427)..........108
Figure 4.5: Percentage of responses (by gender) in agreement with the statement ‘If I work hard enough I will be able to understand all of the science topics on the course’. ....111
Figure 4.6: Stage when students are most interested in science as perceived by teachers (Nteachers= 77). .........................................................116
Figure 4.7: Students’ responses to the statement ‘I explain my own ideas about each new science topic to the teacher’ according to year group (N1st year= 482, N2nd year= 476, N3rd year= 457, 12 respondents in unknown year group). ........................................119
Figure 4.8: Students’ agreement with the statement ‘I want to well in science class because it is important to show my family, friends and teacher that I am able to do well’ (Nmales= 662, Nfemales= 759, 6 respondents of unknown gender). .................................122
Figure 4.9: Respondents’ indication as to how often they perform certain activities in their science class (Nstudents=1427). .................................................................126
Figure 4.10: Students’ level of interest in the physics, chemistry and biology aspects of science (Nstudents= 1427). .................................................................132
Figure 4.11: Students’ levels of agreement with the statement ‘I think physics is an interesting part of science’ (Nmales= 662, Nfemales= 759, 6 respondents of unknown gender). 133
Figure 4.12: Students’ level of agreement with the statement ‘I think chemistry is an interesting part of science’ ($N_{males}$ = 662, $N_{females}$ = 759, 6 respondents of unknown gender). .......................................................................................................................... 133

Figure 4.13: Students’ levels of agreement with the statement ‘I think biology is an interesting part of science’ ($N_{males}$ = 662, $N_{females}$ = 759, 6 respondents of unknown gender). 134

Figure 5.1: Cartoon depicting the education system’s approach to assessment (source: Marquette University 2012). .................................................................168

Figure 6.1: Summary of the main findings from the research project. ......................... 172
<table>
<thead>
<tr>
<th>Table 2.1</th>
<th>Practical outcomes of mastery and performance goal orientations</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 2.2</td>
<td>Characteristics of autonomy-supportive versus controlling instructional practices</td>
<td>17</td>
</tr>
<tr>
<td>Table 2.3</td>
<td>Recommendations for teachers to facilitate students’ self-efficacy</td>
<td>24</td>
</tr>
<tr>
<td>Table 2.4</td>
<td>Summary of international review studies carried out on students’ motivation in science</td>
<td>39</td>
</tr>
<tr>
<td>Table 2.5</td>
<td>Overview of the post-primary school structures employed in Ireland, Scotland, England, Wales, Australia, Canada and the USA</td>
<td>47</td>
</tr>
<tr>
<td>Table 2.6</td>
<td>Frequently used self-report motivation questionnaires in science education</td>
<td>50</td>
</tr>
<tr>
<td>Table 3.1</td>
<td>Breakdown of post-primary schools in Ireland according to school type</td>
<td>81</td>
</tr>
<tr>
<td>Table 3.2</td>
<td>Breakdown of post-primary schools in Munster according to school type</td>
<td>81</td>
</tr>
<tr>
<td>Table 3.3</td>
<td>Overview of the participating schools by school type and school gender</td>
<td>85</td>
</tr>
<tr>
<td>Table 3.4</td>
<td>Profile of the student respondents</td>
<td>86</td>
</tr>
<tr>
<td>Table 3.5</td>
<td>Participant profile of the teacher interviews</td>
<td>90</td>
</tr>
<tr>
<td>Table 3.6</td>
<td>Student profiles involved in the focus groups</td>
<td>90</td>
</tr>
<tr>
<td>Table 3.7</td>
<td>Cronbach’s alpha coefficients for the scales used in the student questionnaire</td>
<td>96</td>
</tr>
<tr>
<td>Table 4.1</td>
<td>Significant differences between science self-concept and gender ($N_{males}=662$, $N_{females}=759$, 6 respondents of unknown gender)</td>
<td>111</td>
</tr>
<tr>
<td>Table 4.2</td>
<td>Significant differences between students’ interest in science and year or gender ($N_{males}=662$, $N_{females}=759$, 6 respondents of unknown gender, $N_{1st\ year}=482$, $N_{2nd\ year}=476$, $N_{3rd\ year}=457$, 12 respondents in unknown year group)</td>
<td>118</td>
</tr>
<tr>
<td>Table 4.3</td>
<td>Significant differences relating to specific science subjects with gender ($N_{males}=662$, $N_{females}=759$, 6 respondents of unknown gender)</td>
<td>132</td>
</tr>
</tbody>
</table>
Chapter 1: Introduction

This chapter aims to introduce the overall research project which is based on the investigation of students’ motivation in science at junior cycle level in Ireland. A background to this project will be provided and the purpose of this study will be outlined. The research questions, which the overall study aims to answer, will be defined and a structural overview of the various chapters of this report will be given.

1.1 Background to Project

Too many young students are being turned off science too soon. A State of the Nation report carried out by the Royal Society of Chemistry in 2008 stated that there are two main dimensions to this problem. Firstly, there is an enduring concern that students are not being engaged and motivated by school science. Secondly, there is the problem of the participation rates of students in science. Students appear to have already “switched-off” from school science before the period of compulsory schooling has ended (age 15-16) in the UK, and before decisions about continuing subject choices must be made. Furthermore, international studies, such as the Relevance of Science Education (ROSE) project, indicate that school science is failing in many ways, for example, where ‘school science is [regarded as] less interesting than other subjects’ (Sjøberg and Schreiner 2010). Similar findings have been published in Ireland. For instance, a longitudinal study exploring Irish post-primary school students’ experiences through the three years of the junior cycle (lower secondary cycle), found that 2nd year students (13-14 years old) report liking subjects where the learning is organised in an active, project-like way, but, science was not listed as one of these subjects (Smyth et al. 2006).

In addition to this, it has been found that students’ engagement and motivation towards science in school depends on age. Bennett and Hogarth’s (2009) study in the UK found that young students enter post-primary school with positive attitudes towards science; however, this positivity declines most sharply between the ages of 11 and 14. Similarly, the 2011 Trends in International Mathematics and Science Study (TIMSS) reported that 53% of the 4th grade students (9-10 years old) who were assessed agreed with the statement that they “like learning science”. This is in contrast to only 35% of 8th grade students (13-14 years old) who agreed with this statement (Martin et al. 2012). Again, more specifically related to Ireland, it has been noted that this stage (13-14 years old, second year in post-primary school) is the
critical point where students either engage or disengage from schooling in general (Smyth 2009).

1.2 Purpose of this Study
Hence, the focus of this project is to investigate the problem of students’ decline in motivation in junior cycle science in Ireland and to develop an understanding of the factors that affect students’ motivation in science. Can students be reengaged in science?

1.3 Research Questions
The central research questions of this study are:

1. Are Irish students motivated to study junior cycle science in school?

2. In what way do junior cycle science students’ motivational orientations differ in the first three years of post-primary education in Ireland?

3. What are the main factors that affect student motivation in junior cycle science in Ireland?

In addition to these research questions, this thesis will take a critical look at the whole concept of motivation and its measurement.

1.5 Overview of Chapters
Chapter 1 - Introduction:
This chapter provides a brief background for the rationale for this project. The project aims are outlined with the guiding research questions, and each of the chapters of this thesis are introduced here.

Chapter 2 – The Literature Review:
This chapter aims to explore relevant education and science education research on motivation. It will be divided into three main sections: Motivation, Motivation in Education and Motivation in Science Education. In the final section of this chapter, Motivation in Science Education, existing literature on students’ motivation in science will be outlined, studies carried out on students’ motivation in science will be reviewed, and finally factors influencing students’ motivation in science will be discussed.

Chapter 3 – The Methodology:
Both quantitative and qualitative research methods were used in this project as described in this chapter. The steps involved in designing, distributing and evaluating the quantitative (student and teacher questionnaires) and qualitative aspects (student focus groups and teacher interviews) of this study are outlined in this chapter in addition to the rationale for each of the methods used. The validity and reliability of the chosen methods are discussed as well as the ethical implications of the project.

Chapter 4 – Results:

This chapter presents the findings of both the quantitative and qualitative parts of the study. Triangulation of findings is used by comparing the interview and focus group data with that obtained from the questionnaires.

Chapter 5 – Discussion:

In this chapter the three research questions are addressed. Each research question is answered with relevance to the findings presented in Chapter 4 and the literature presented in Chapter 2. Implications of this research are also outlined at end of this chapter.

Chapter 6 – Conclusion:

This chapter provides a summary of the main findings of this research project, highlighting the unique contribution of this research. Future work planned for the immediate future is also outlined, before concluding with a personal reflection of the author’s research journey.

After this introduction, the purpose and significance of this research project are clear. Research questions have been defined, and chapters have been outlined. It is now possible to explore the literary information surrounding this project.
Chapter 2: Literature Review

2.1 Literature Review Introduction
The declining trend in students’ motivation and engagement in lower-secondary science has been discussed in Chapter 1. The purpose of this chapter is to review the literature on motivation, specifically on motivation in science education, in order to understand what factors affect student motivation in lower-secondary science in Ireland.

To begin this chapter, motivation and the theories that underpin the concept will be discussed first. Then, the factors that have been shown to impact on students’ learning motivation will be reviewed, before specifically investigating the influences on students’ motivation in science education.

2.2 Motivation
The term motivation is derived from the Latin verb movere, which means to move. Some researchers suggest that motivation is the “attribute that moves us to do or not to do something” (Broussard and Garrison 2004, p.106), or that it is “the inclination to do certain things and avoid doing some others” (Hannula 2006, p. 165). For this study, the term motivation will be defined as “a complex part of human psychology and behaviour that influences how individuals chose to invest their time, how much energy they exert in any given task, how they think and feel about the task, and how long they persist at the task” (Urdan and Schoenfelder 2006, p. 332). At different points in the history of research on motivation, and in different sub-disciplines of psychology, motivation has been conceptualised in various ways. Before moving on to explore the main theories that underpin motivation in education and psychology, it must be acknowledged that most classical theories of motivation view motivation as a unitary phenomenon, “one that varies from very little motivation to act to a great deal of it” (Ryan and Deci 2000, p. 54). It has been assumed that motivation can be characterised in some quantitative manner between two endpoints on a single continuum (Linnenbrink and Pintrich 2002). Yet, even a brief reflection suggests that motivation is hardly a unitary phenomenon. People have not only different amounts of motivation, but also different kinds of motivation, as will be described in this chapter.
2.2.1 Theoretical Frameworks of Motivation
A plethora of motivational models have been developed over the past number of decades. It has been well documented however, that the concepts of motivation in education and psychology research have been largely based on the four main ideologies of: needs, goals, intrinsic versus extrinsic motivation, and interest. The development of each new theory of motivation brings about a shift from the more general cognitive models to the more affective and socially-cognitive models, due to the realisation of the importance of the social context in motivation.
Figure 2.1: Concept map of the main theories underpinning motivation in education as will be explored in this thesis.
Needs
One of the first theoretical frameworks for understanding motivation was based upon Maslow’s Hierarchy of Human Needs (1943). According to Maslow, there are five sets of needs, which can be referred to as basic needs. These are, briefly, physiological, safety, love, esteem, and self-actualisation or the desire for self-fulfilment. Maslow suggested that people are motivated by the desire to achieve or maintain the various conditions upon which these basic satisfactions rest (ibid). A number of more recent frameworks of motivation in education have been based on the Hierarchy of Human Needs, namely Deci et al.’s (1991) Self-Determination Theory (SDT). The SDT focuses primarily on three psychological needs that are inherent in human life: the need for competence, relatedness, and autonomy.

Competence refers to the desire to master and to be competent in interactions with the environment. Relatedness reflects a wanting to belong or to be attached to a group, and autonomy involves feeling in control of one’s own behaviour. According to Deci’s (1991) theory, if these needs cannot be satisfied, then motivation, cognitive and affective functions will suffer.

A significant assumption of this theory is that these needs are innate for all individuals in all cultures and apply across all situations. The next theory that will be discussed, the Achievement Goal Theory of motivation, accounts for the fact that motives vary substantially between individuals, with certain motives being more important for some people than others.

Goals
One of the most active areas of motivation research in the education context over the past 20 years has been research on achievement goal orientations. Goal orientations are defined as the reasons for pursuing and engaging in a learning task (Pintrich 2003). There are two general goal orientations that concern individuals’ purposes for approaching and engaging in a task (Linnenbrink and Pintrich 2002). Goal theorists have used a variety of labels to refer to these two goals including learning and performance goals (Dweck and Leggett 1988), task and ability goals (Maehr and Midgley 1996), task-involved and ego-involved (Nicholls 1984), and mastery and performance goals (Ames 1992; Elliot 1997; Elliot and Church, 1997; Harackiewicz et al. 1998). For the purpose of clarity, these goals will be referred to as mastery and performance goals throughout this thesis.

Mastery goals concern the degree to which students or individuals perceive themselves to be participating in a task for reasons such as challenge, curiosity, acquiring new skills, trying to
understand their work, and improving their level of competence (Hidi and Harackiewicz 2000). Having a mastery goal orientation towards an academic task indicates that the student’s participation in the task is an end all to itself, rather than participation being a means to an end (Pintrich and deGroot 1990).

In contrast to mastery goals, performance goals are postulated to lead individuals to seek positive evaluations of their ability and to avoid negatives ones, to try to outperform others, and to consider ability, rather than effort, the cornerstone of successful performance (Hidi and Harackiewicz 2000). Those with performance goals are preoccupied with questions like ‘will I look smart?’, or ‘will I outperform others?’ (Lai 2011, p.11). Students with these types of goals are more likely to select tasks that they know they can complete (Ames 1992).

This theory of Achievement Goal Orientation considers the notion that not all individuals are motivated by the same basic needs or goals, yet, it fails to acknowledge that individuals’ motives may not be stable personality traits, and instead, they may be situated and malleable.

The Intrinsic versus Extrinsic Theory of motivation, which shares many similarities to Achievement Goal Theory, describes how individuals may be intrinsically or extrinsically motivated for a particular task, depending on the topic domain and/or the environment in which the task is being carried out.

**Intrinsic Versus Extrinsic Motivation**

The approach of distinguishing between intrinsic and extrinsic motivation was an early approach to investigating motivation in education. Findings from these early studies suggested that motivation was a dichotomous concept, where individuals either held an intrinsic or extrinsic motivation orientation towards specific tasks. Intrinsic motivation is typically defined as the motivation to engage in activities for their own sake (Hidi and Harackiewicz 2000). Extrinsic motivation, on the contrary, reflects an activity or behaviour undertaken for some instrumental value or external reason (Pintrich 2003). For example, a student could be motivated to learn a new set of skills because he or she understands their potential utility or value (intrinsically motivated), or because learning the skills will yield a good grade and the privileges that a good grade affords (extrinsically motivated) (Ryan and Deci 2000).

Furthermore, contemporary research in this field has expanded the traditional distinction between intrinsic and extrinsic motivation to a more complex differentiation of extrinsic
motivation. Four types of extrinsic motivation have been identified: (a) *external* extrinsic motivation, (b) *introjected* extrinsic motivation, (c) *identified* extrinsic motivation, and (d) *integrated* extrinsic motivation (Ryan and Deci 2000). These differentiations reflect a consortium from the most externally controlled types of extrinsic motivation to the most internally controlled.

Intrinsic motivation is often regarded as the optimum form of motivation. It has been widely considered for some time as the natural wellspring of learning (Ryan and Stiller 1991). Conversely, extrinsic motivation has typically been characterised as the pale and impoverished form of motivation (e.g. deCharms 1968). It is emerging however, that extrinsic motivation may also have a positive impact on student learning (Hidi 1990; Ryan and Deci 2000), particularly when it is not possible to rely on intrinsic motivation to foster learning. For instance, it has been reported that extrinsic motivation, elicited by the possibility of a good grade or positive teacher-feedback, may help to maintain students’ motivation and performance, even when individuals have no intrinsic motivation to learn about a particular topic (Hidi and Harackiewicz 2000). It has also been argued, in conjunction with the differentiated model of extrinsic motivation that students can perform extrinsically motivated actions with resentment, resistance, and disinterest, or, alternatively, with an attitude of willingness that reflects an inner acceptance of the value or utility of a specified task (Ryan and Deci 2000).

It is clear that the Intrinsic versus Extrinsic model of motivation is a more content- and situation-specific model of motivation than Maslow’s (1943) Hierarchy of Human Needs and the Achievement Goal Theory of motivation. The Intrinsic versus Extrinsic model incorporates the notion that individuals’ motivation type and level depend on social factors, such as school contexts, personal development and learning environments, to name but a few.

A significant aspect of motivation theory that has largely been ignored up until this point in educational psychology literature however, is the affective domain of motivation (Boakaerts and Boscolo 2002). It has been well documented that interest has both an affective and a cognitive component (Hidi *et al.* 2004). Hence, the final model of motivation that will be reviewed in this section is that of interest.
**Interest**

Firstly, what is worth emphasising here before exploring the construct of interest in detail, is that the importance of affect\(^1\) and emotion as a mediator of motivation and cognition was only beginning to be widely recognised by researchers in the 1990s (e.g., Damasio 1994, 2003; Alexander and Murphy 1998; Panskepp 1998, 2003; Dai and Sternberg 2004). Prior to this, affect was considered simply as an outcome of cognitive processes (Meyer and Turner 2002). In the 1990s affect was realised by researchers to have an integral role in understanding students’ goals and their learning strategies (Meyer and Turner 2002).

Returning to the concept of interest more specifically, it is important to point out that interest is often described as synonymous to the construct of motivation, both in lay terms and in academic literature. Despite this, there is a “major difference between a motive….and an interest” according to Bandura (1986, p. 243). Interest is conceptualised as an interactive relation between an individual and certain aspects of his or her environment (Hidi and Harackiewicz 2000). The potential for interest resides in the person, but, the environment and the content define the direction of the interest and contribute to its development (Hidi and Renninger 2006). By way of contrast, a motive, put simply, is an inner drive to act (Bandura 1986).

Furthermore, interest is categorised into two main categories: *individual* interest and *situational* interest (Hidi and Harackiewicz 2000; Krapp and Prenzel 2011), similar to the Intrinsic versus Extrinsic Theory and the Achievement Goal Theory of motivation. *Individual* interest is sometimes referred to as ‘personal’ interest, and it is defined as “a relatively enduring predisposition to attend objects, events, ideas etc., and to reengage with particular content” (Hidi 2006, p. 72). This personal disposition develops over time and it is associated with increased knowledge, value and positive feelings (Renninger 1990, 1992, 1998; Schiefele 1991, 1998).

*Situational* interest, on the other hand, has been described as an interest that is primarily caused by external factors (Hidi 1990) and it is more immediate and transitory than personal interest (depending on the task environment) (Hidi and Harackiewicz 2000). Although personal and situational interests are distinct, they are not dichotomous phenomena, but rather can be expected to interact and influence each others’ development (Hidi 1990; 1997).

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\(^{1}\) Affect refers to emotion or desire as influencing behavior.
Hidi and Anderson 1992). Situational interest, it has been reported, can contribute to the development of long-lasting individual interests (Hidi and Harackiewicz 2000). This suggests that creating environments that stimulate situational interest is one way for schools to motivate students to help them to make cognitive gains in areas that initially hold little interest for them. Ideally, catering to the personal interests of individuals in the classroom would promote learning for all students, but in reality, this would be an extremely time and effort consuming task because not all children have interests that are easily adaptable to school settings and academic learning (Heyman and Dweck 1992; Nisan 1992; Hidi and Harackiewicz 2000).

To sum up, interest is central to motivation research. The focus on this motivational variable in the literature mirrors the cognitive revolution, where purely cognitive frameworks of motivation were replaced or enhanced by more socially-cognitive and affective models. Yet, it is still not clear how each of the aforementioned theories of motivation combine together or succeed each other in representing the “complex part of human psychology” (Urdan Schoenfelder 2006, p. 332) that is motivation. In an attempt to unify this representation, the major factors that affect students’ learning motivation will be investigated in the following section, Motivation in Education.

2.2.2 Conclusion

The motivational models discussed here do not represent the entire field of associated research. Rather, the four main models of motivation, as identified in the introduction, have been traced through the history of motivational research and defined accordingly. The implications for student learning for each model have been explored within the parameters necessary for this thesis. A significant finding of this review is that motivation “cannot be divorced from the social fabric in which it is embedded” (Weiner 1990, p. 621) and that it involves a constellation of beliefs, perceptions, values, interests and actions that are all closely related (Lai 2011). A number of these perceptions will be the focus of the following section, where particular emphasis will be placed on students’ learning motivation in the school setting.

2.3 Motivation in Education

The aim of this section of the chapter is to try to understand why some students are motivated in school and others are not. As outlined previously, there are a multitude of factors that affect students’ motivation. Four of these factors that will be discussed here in detail, as these
particular factors have been postulated to dominate students’ learning motivation (Pintrich and Schunk 1996; Brophy 1998; Tuan et al. 2005); these are students’ goal orientation, learning environment, task value and students’ self-efficacy.

Firstly, and following on from the previous section, an investigation will be carried out into how students’ goals in relation to education affect their motivation in school. The impact of the school environment in shaping these goals will then be explored, before discussing the content of the school work, and how students’ feelings about this work can impact significantly on their motivation. The structure of the exploration of these four factors will take the following format: each of the variables will be defined, examples of the outcomes of the variables in the school classroom will be provided, and suggestions for how to promote students’ motivation in light of these variables will be offered.

2.3.1 Goal Orientations
The background to goal orientations has been presented at the beginning of this chapter. It is clear that goal orientations, like many other motivational constructs, are divided into two main categories: the mastery goal orientation and the performance goal orientation. It is argued that these goals are what ultimately shape students’ outlook in and towards education. Hence, a comprehensive exploration into the effects of these goals in the classroom will be conducted here.

A review of the findings from numerous studies carried out on the implications of students’ goal orientations towards learning reveal that mastery goal orientations tend to result in positive cognitive strategy use, self-regulation and achievement, whereas, the performance goal orientation tends to foster less adaptive, and even maladaptive outcomes. The findings from this review are tabulated below in Table 2
Table 2.1: Practical outcomes of mastery and performance goal orientations.

<table>
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<tr>
<th>Student Mastery Goal Outcomes</th>
<th>Reference</th>
<th>Student Performance Goal Outcomes</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of elaboration and organisational skills</td>
<td>Pintrich and deGroot 1990</td>
<td>Positive evaluations of ability are sought</td>
<td>Nicholls 1984</td>
</tr>
<tr>
<td></td>
<td>Archer 1994</td>
<td></td>
<td>Ames 1992</td>
</tr>
<tr>
<td></td>
<td>Pintrich 2000</td>
<td></td>
<td>Hidi and Harackiewicz 2000</td>
</tr>
<tr>
<td>Achievement of self-referenced standards</td>
<td>Hidi and Harackiewicz 2000</td>
<td>Avoidance of negative evaluations of ability</td>
<td>Ames 1992</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hidi and Harackiewicz 2000</td>
</tr>
<tr>
<td>Expend effort</td>
<td>Pintrich and Schunk 1996</td>
<td>Effort withdrawal</td>
<td>Meece et al. 1988</td>
</tr>
<tr>
<td></td>
<td>Hidi and Harackiewicz 2000</td>
<td></td>
<td>Pintrich 1989</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Graham and Golan 1991</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Utman 1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hidi and Harackiewicz 2000</td>
</tr>
<tr>
<td></td>
<td>Urdan and Schoenfelder 2006</td>
<td></td>
<td>Pintrich 1989</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Graham and Golan 1991</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Utman 1997</td>
</tr>
<tr>
<td>Effective study strategies</td>
<td>Nolen and Haladyna 1990</td>
<td>Superficial learning strategies - rote memorisation, inefficient use of time</td>
<td>Meece et al. 1988</td>
</tr>
<tr>
<td></td>
<td>Meece and Holt 1993</td>
<td></td>
<td>Graham and Golan 1991</td>
</tr>
<tr>
<td></td>
<td>Middleton and Midgley 1997</td>
<td></td>
<td>Karabenick and Collins-Eaglin 1997</td>
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<td></td>
<td></td>
<td></td>
<td>Utman 1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Elliot et al. 1999</td>
</tr>
<tr>
<td>Development of willpower and self-control</td>
<td>Pintrich 2003</td>
<td>Impaired problem-solving</td>
<td>Meece et al. 1988</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pintrich 1989</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Graham and Golan 1991</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Utman 1997</td>
</tr>
<tr>
<td>Achievement</td>
<td>Schunk 1996</td>
<td>Achievement</td>
<td>Bouffard et al. 1995</td>
</tr>
<tr>
<td>Persistence in the face of difficulty or failure</td>
<td>Hidi and Harackiewicz 2000</td>
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<td>-------------------------------------------------</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Urdan and Schoenfelder 2006</td>
<td></td>
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</tr>
<tr>
<td>Intrinsically motivated</td>
<td>Urdan and Schoenfelder 2006</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Involved in learning process</td>
<td>Nicholls et al. 1989</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kaplan and Maehr 2007</td>
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</table>

It is clear from Table 2.1 that the adoption of mastery goals in school correlates with a positive constellation of motivational and academic outcomes. The adoption of performance goals, on the contrary, tends to be associated with a negative pattern of motivational beliefs and behaviours. As a consequence of much of these findings, in an effort to improve students’ motivation levels in schools, educators have been encouraged to foster students’ mastery goal orientation. This can be achieved, it is reported, by setting up certain goal structures\(^2\). Various structures in the classroom environment influence students’ perceptions of the classroom goal structure, which in turn relate to students’ own adoption of mastery or performance goals (Meece 1991; Ames 1992; Blumenfeld 1992; Meece et al. 2006). For example, evaluating students on their improvement over several drafts of a written assignment can help to focus students on learning (mastery goal approach), as opposed to focusing on performing better than others (performance goal approach) (Urdan et al. 1999; Linnenbrink and Pintrich 2002). By promoting development, improvement and learning for understanding, using assessment for learning, educators can convey to students that everyone can learn and that the process of learning and developing skills is more important that who gets the best grades on tests (Urdan and Schoenfelder 2006).

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\(^2\) Goal structures refer to messages in the learning environment (i.e. the classroom or school) that make certain goals salient (Ames 1992).
A further illustration of the effects of these goal structures on students’ motivation levels and orientations is evident in students’ transition from primary to post-primary school. Research studies have shown that when students move from the last year of elementary school (equivalent to primary school in Ireland) into middle school (post-primary school), a particularly negative pattern of motivational, affective, and achievement outcomes is associated with a perceived decrease in the mastery goal structure of the classroom across the transition (Eccles and Midgley 1988, 1990; Meece 1991; Lepper et al. 1997; Wigfield et al. 1997; Covington 2000; Urdan and Midgley 2003). The difference in the types of tasks for example, the authority structure and the evaluation strategies used can convey very different messages to the students regarding the general goal structure of the new classroom. This leads to the next point of discussion, which is that it may be both troublesome and unnecessary, from an educational perspective, to try to focus solely on nurturing students’ mastery goal orientations.

It is not plausible to assume that all students will adopt a purely mastery goal orientation, particularly when most education systems in the world are predicated on the idea of academic ability and the achievement of results. Furthermore, all children have interests, motivation to explore, to engage, but not all children have academic interests and motivation to learn to the best of their abilities in school. An interesting example related to this is provided by Hidi and Harackiewicz in their (2000) study ‘Motivating the Academically Unmotivated’ where they explain that

“Some children find physical activities much more enjoyable than mental ones. These children’s interests may orient them towards sports, and their mastery goals coupled with their physical interests can drive them to practice swinging their bats thousands of times to perfect their hitting.”

(Hidi and Harackiewicz 2000, p.168)

What this example highlights is that children often practice these types of skills with an eye toward ultimately winning matches and competitions. In essence, many children effectively combine mastery goals (improving their skills and striving for “personal bests”) with performance goals (trying to outperform others and win), which are both probably necessary to achieve athletic excellence. This suggests that despite the emphasis on the dichotomy of goals in much of the research in this area, performance and mastery goals are not two distinct entities, but can complement and reinforce each other. The advantages of having a
combination of goals in the world of sport is perhaps more explicit than in the academic world. It must be pointed out that there has been a general reluctance to recognise the potential additional benefits of performance goals in academic learning in the discourse of Achievement Goal Theory.

Referring back to Table 2.1, it is clear that performance goals do not always have negative effects on learning and motivation to learn. This has been argued even for individuals who are low in perceived competence (Miller et al. 1993; Elliot and Church 1997; Kaplan and Midgley 1997). What is certainly evident is that students who pursue performance goals are likely to show less persistence and more frequent use of shallow learning strategies than those who adopt mastery goals, however, it is also apparent that performance goals are associated with high achievement in school (for further reviews of this research see Elliot 1999; Harackiewicz et al. 2000; Midgley et al. 2001).

Over the last number of decades, there has been an emphasis on reducing external motivational influences, and trying to energise intrinsic sources. The latter is a worthy goal that should be endorsed, but energising intrinsic sources of motivation such as mastery goal orientations, does not necessarily mean that all extrinsic sources are suspect. In fact, by focusing on the enhancement of external sources, such as situational interest in classrooms, educators can find ways to foster students’ involvement in specific content areas and accordingly increase levels of academic motivation (Lepper 1985; Mitchell 1993; Hoffmann and Haussler 1998; Bergin 1999). Hence, the next influential motivational factor to be discussed is that of the learning environment.

2.3.2 Learning Environment
The learning environment in the classroom context comprises of teachers’ teaching strategies or types of instruction, student-teacher and student-student interactions, and class activities or tasks (Pintrich and Schunk 1996; Brophy 1998; Hanrahan 1998). The concept and significance of the learning environment has been introduced previously in the form of goal structures. Goal structures directly relate to teachers’ instructional practices, which is what will be considered here first and foremost.

**Instructional Practices**
To begin with it is important to bear in mind, as outlined previously, that motivation is not a stable trait of an individual, but is more situated, contextual, and domain-specific. In other words, not only are students motivated in multiple ways, but their motivation can vary
depending on the situation or context in the classroom or school. This suggests that instructional efforts and the design of classrooms and schools can make a significant difference in motivating students (Linnenbrink and Pntrich 2002; Krajcik et al. 2003). Research examining how educators can meet the needs of students in school has mostly focused on the contrast between autonomy-supportive and controlling instructional practices (Urdan and Schoenfelder 2006). Table 2.2 summarises the characteristics of each type of practice based on works by Deci and Ryan (1985), Brophy (1986), Christophel (1990), Black and Deci (2000), Assor and Kaplan (2001) and Urdan and Schoenfelder (2006).

Table 2.2: Characteristics of autonomy-supportive versus controlling instructional practices.

<table>
<thead>
<tr>
<th>Autonomy-Supportive</th>
<th>Controlling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listens to student input.</td>
<td>Discourages students from voicing their own opinions.</td>
</tr>
<tr>
<td>Gives informative feedback.</td>
<td>Gives feedback based on students’ ineptitude.</td>
</tr>
<tr>
<td>Shows a sense of affection or care towards students.</td>
<td>Uses threats and competition to control behaviour.</td>
</tr>
<tr>
<td>Offers students choice about what work to do or how to complete it.</td>
<td>Makes numerous controlling statements (e.g. “You need to know this for the test”)</td>
</tr>
<tr>
<td>Provides optimally challenging tasks.</td>
<td>Imposes strict deadlines for work.</td>
</tr>
<tr>
<td>Conveys a sense of enthusiasm.</td>
<td></td>
</tr>
</tbody>
</table>

When these characteristics are viewed in light of the Self-Determination Theory (SDT), it is clear that the need for autonomy, competence and relatedness are all supported by the more autonomy-supported instructional practice, which in turn is suggested to enhance students’ intrinsic motivation (Deci et al. 1991).

An elaboration of autonomy-supported instruction is that of scaffolding, which follows the Gradual Release of Responsibility Model (Grant et al. 2012). This method of instruction aims to engage students in ways that help them to motivate themselves, by internalising and controlling their learning goals (Meyer 1993). Scaffolded instruction concentrates on constructive approaches to accepting mistakes that encourage risk-taking and the pursuit of challenges, and avoids methodical teaching techniques that require complete compliance (Turner and Meyer 1999). The idea follows that as students gain confidence and competence in a particular task, the scaffolding from the teacher can be reduced, while the student can internalise the methods and strategies needed for completing the work well. Too much
scaffolding, or improper scaffolding, however, can be detrimental to learning and motivation. If students do not become actively involved, for instance, the teacher’s support will become a crutch that artificially props up student learning. Conversely, not providing students with sufficient scaffolding gives the students too much freedom in decision making which may be confusing and yield counterproductive outcomes (Vedder-Weiss and Fortus 2012). Meyer (1993) outlined the three primary ways to create scaffolded instruction and they are: making the topics personally meaningful to students, giving the students responsibility for their learning, promoting student self-regulation, and by providing intrinsic support for learning by giving it value and fostering confidence. This model of scaffolding is also consistent with the recommendations of SDT research (Zimmerman et al. 1996).

It is important to note that it has been suggested that school-wide characteristics may play a central role in influencing students’ motivation, even beyond the influence or practices of a certain teacher (Maehr and Anderman 1993; Kaplan and Maehr 1997; Stefanou and Parkers 2003; Fredericks et al. 2004). For instance, if teachers’ emphases in a science class contradict the emphases of the school, the effectiveness of the teachers’ emphases might be limited. Such school-wide characteristics have been termed “school culture” and they include the stress on certain goals, purposes and values (Maehr and Anderman 1992) as well as the school’s regularities and practices derived from them (Sarason 1996). To the best of the author’s knowledge, no report has been published of a study in science education which has considered such influences. Hence, this area requires further research in terms of understanding the factors which may affect students’ motivation to learn science, not only in terms of the teacher and their practices in the classroom, but also the school culture.

To summarise, a large body of research highlights the possible influences of the classroom environment on students’ learning motivation. It is quite clear that instructional practices not only influence students’ academic achievement and learning strategies, but they also affect the individual development of the student, in terms of students’ goal orientations in particular. Using learner-centred practices that involve promoting high-order thinking, honouring student voices and adapting instruction to individual and developmental needs fosters a mastery goal orientation in students. Creating supportive relations in the classroom has also been emphasised as a significant factor in influences students’ motivation in school. Thus, this will be discussed in greater detail below.
Social Interactions

Schools and classrooms are, by definition, social environments (Urdan and Schoenfelder 2006). Social environments may be defined as “the many situations in which individuals must interact with each other and they are shaped by the attitudes and behaviours of others” (Urdan and Schoenfelder 2006, p. 340). The classroom environment for instance, guides how students learn, their attitudes towards school and study (Wentzel 1997). Moreover, within any single classroom, students have social interactions and build social relationships with their teachers, close friends and even with non-friend classmates. The impact that the interactions within these relationships have on students’ motivation in school will be now be explored.

There are two main factors within the teacher-student relationship that are influential in determining students’ motivation in school. They are care and support (Noddings 1992; Turner and Meyer 1999; Wentzel and Battle 2001). Teacher “caring” has a direct effect on students’ attitudes towards academic and social goal pursuits (Wentzel 1994, 1997; Jarvis and Pell 2005; Reiss 2005). Teachers perceived as “caring” are reported to have qualities similar to those of an authoritative parent where they provide rules but avoiding the restriction of autonomy (Noddings 1992). The outcome of such relationships is that students respond with greater engagement and effort in class when they believe that their teachers care about them (Turner and Meyer 1999).

Teacher support is also a predictor of effort and the pursuit of social goals (Wentzel 1997). Looking at this from a negative perspective, students who perceive their teachers to be cold and harsh are found to consistently display poor social behaviour, and to have low social goals, as well as achieving lower academically (Wentzel and Battle 2001).

Exemplifying the further significance of the teacher-student relationship is the critical role of the teacher for students who may be affected by negative social environments, such as difficult family backgrounds or rejection by peers. The teacher’s support and acceptance in these cases, it has been reported, compensates for students’ dwindling motivation and self-confidence, and such teachers are regarded as mentors (Darling et al. 1994). Although many studies have indicated that parents influence their children’s learning motivation (Breakwell and Beardsell 1992; Zimmerman et al. 1992; Kamins and Dweck 1999), family variables have been stated to be less influential than school variables (Simpson and Oliver 1990).

Furthermore, Maehr (1991) found that the comparative effect of family and school on students’ motivation changed with age. Young students’ motivation was relatively more
correlated to their parents’ emphases, whereas older students’ motivation was relatively more correlated to their teachers’ and schools’ emphases.

In a similar vein, the student-student relationship can have quite a significant impact on students’ motivation in school. During adolescence many students experience a decline in academic motivation (Wheelock and Dorman 1988; Eccles and Midgley 1989; Simpson and Oliver 1990). As adolescents’ attitudes (towards science in particular) are highly correlated with their friends’ attitudes (Simpson and Oliver 1990), a crucial factor affecting students’ motivation is the values which students decide to accept and adopt or reject. Explaining this in more detail, a student may select friends who devalue academic effort and achievement. This leaves the student in a situation whereby they have to choose between the values the school endorses (i.e. effort, achievement, etc.) and those that their friends promote (i.e. devaluing of schooling) (Phelen et al. 1991). This can be a particularly difficult thing to do for students during adolescence. At this point in their life social relationships with peers assume a prominent role and it is important that they feel connected to a peer network in school (Hawkins and Berndt 1985; Berndt and Keefe 1992; Juvonen and Cardigan 2002). Possible ways for teachers to guide students through this often difficult period, and to enhance their motivation, are to create opportunities for students to get to know each other by employing cooperative grouping structures in the classroom or by providing students with the opportunity to choose the social organisation of their learning activities (Urdan and Schoenfelder 2006).

In sum, teachers who are perceived as being controlling, cold and uncaring tend to discourage students’ fulfilment of all three of their needs for competence, autonomy and relatedness (Urdan and Schoenfelder 2006). Relatedness needs in particular become difficult for adolescent students to fulfil, and some students will ultimately feel forced to choose between academic achievement and maintaining social bonds.

Moving on from interactions and teaching practices, class activities are the third major factor contributing to the learning environment. This will be discussed separately as Task Value in the following section, as it is regarded as a major determinant of student learning motivation.

2.3.3 Task Value
Task value refers to the student's evaluation of how interesting, how important, and how useful a task is: "What do I think of this task?" (Pintrich et al. 1991). In an effort to explain why students want to succeed on a particular task, three components of task value have been
proposed as influential factors and have been termed; intrinsic value, attainment value, and utility value (Eccles 1983; Eccles and Wigfield 1995). Briefly, intrinsic value relates to students’ general enjoyment of the task or subject matter, attainment value refers to the importance students place on a particular task, and utility value concerns students’ perceptions of the usefulness of the task in terms of their daily lives or future career-related goals. Students who are convinced that their learning activity is important, interesting and useful are more inclined to expend greater effort and persist longer towards completing the activity (Wolters and Rosenthal 2000), even if students feel themselves that they are not overly competent in doing so (Schunk and Zimmerman 2007).

In the context of the school classroom, it has been stated for decades that the observed developmental decline in students’ motivation is a consequence of the “decontextualisation” of learning that takes place in school (Lepper et al. 1997). There is truth in Lepper et al.’s assertion that learning in schools almost:

“Deliberately seeks to divorce the learning of academic skills from the natural contexts in which their interest might be obvious to students. Instead…[schools/teachers] teach subjects in their most abstract form”.

(Lepper et al. 1997)

Creating meaningful contexts for learners has been highlighted by many as a great means of promoting students’ motivation and engagement in schooling (Lepper and Cordova 1992; Parker and Lepper 1992; Brophy 1999; Blumenfeld et al. 2006). The essence of triggering interest lies in finding ways to empower students by helping them find meaning or personal relevance (Mitchell 1993), such as situating the curriculum content in real contexts (Krajcik and Blumenfeld 2006).

Furthermore, studies have indicated that certain modifications to the teaching materials and how tasks are presented, can contribute to the development of situational interest in a variety of areas (see Lepper and Cordova 1992; Hidi and Berndoff 1998; Lepper and Henderlong 2000). Inquiry-based tasks for instance, can enhance the perceived utility value for participating students by providing opportunities for students to engage in authentic scientific activities (Bonney et al. 2005).

In addition to increased levels of situational interest, a further reported outcome of students valuing tasks is that it predicts choice behaviour. This type of choice behaviour may be
characterised as intentions to enrol in future science courses, for example, as well as actual future course enrolment (Pintrich 2003). Expectancy beliefs or competence beliefs, such as self-efficacy, on the other hand, tend to predict achievement once students are enrolled in the course (Pintrich 2003). These findings are yet another illustration of the multiple outcomes and multiple pathways to motivated learning and achievement.

Having established a link between task value beliefs and competence beliefs, it is necessary to explore the concept of self-efficacy more fully. It is important to understand how students’ feelings about school and their perceived competence in completing school related work can affect their motivation.

2.3.4 Self-Efficacy
A component of motivational research that has received much attention is that of self-efficacy (Pajares 1996; Schunk and Miller 2002). Self-efficacy is a specific motivational construct that refers to beliefs about the likelihood of succeeding at a certain task. According to the literature, students are more likely to have an incentive to learn if they believe they can produce the desired outcomes (Bandura 1977). In motivation literature, self-efficacy is defined as “people’s judgements of their capabilities to organise and execute courses of action required to attain designated types of performances” (Bandura 1986, p.391). This definition highlights the fact that self-efficacy is situated and contextualised, rather than a general affective evaluation of the self. For instance, a student might have a high self-efficacy for solving back titration questions in inorganic chemistry, but a lower self-efficacy for understanding mechanism reactions in organic chemistry. These self-efficacy beliefs are distinct from the more general self-evaluation beliefs such as self-concept (i.e. “I’m good at chemistry”) and self-esteem (i.e. “I feel good about myself because I am competent in chemistry”).

According to the literature, when students have high self-efficacy beliefs, that is, they feel confident that they can succeed at a task, they are likely to choose to participate in the task and to expend effort on it (Bandura 1986; Pintrich and Schunk 2002; Linnenbrink and Pintrich 2003; Urdan and Schoenfelder 2006). In addition, high levels of efficacy may also result in students:

- Increasing their persistence on difficult tasks,
- Choosing challenging tasks,
• Adopting self-regulated learning strategies (elaboration, organisation, planning, monitoring and regulation of themselves while working),

• Achieving high levels of performance.


It is clear that these outcomes are similar to those attained by students who are subjected to autonomy-supportive instructional practices and by students who hold a mastery-goal orientation. This is not surprising as all of the aforementioned motivational constructs overlap considerably (Murphy and Alexander 2000). What is interesting to note about these findings however, is that self-efficacy beliefs have been found to be the best predictor of students’ course performance (Zusho et al. 2003). Although this corroborates findings from previous research studies, (Schunk 1989, 1991; Pintrich and Schunk 1996; Bandura 1997, Eccles et al. 1998) it is certainly questionable, particularly when one takes into account that males tend to display higher levels of self-efficacy than females (with reference here to science and mathematics subjects specifically), yet they do not do tend to outperform females (Eisenberg et al. 1996; Eccles et al. 1998; OECD 2007). This will be reviewed in more detail in section 2.4 in light of pertinent findings in science education motivational research.

Before exploring the implications of students’ self-efficacy for classroom practice, it should be stressed that there is an important caveat that should be acknowledged by educators in their attempts to facilitate students’ positive self-efficacy beliefs; that is, students’ self-efficacy beliefs should be realistic. On the one hand, from a motivational perspective and based on the findings as outlined above, it would seem that having as high as possible efficacy and competence beliefs would be useful and would keep students motivated. On the other hand however, from a self-regulatory perspective, when students largely overestimate their capabilities they are less likely to engage in self-regulatory learning strategies to improve their knowledge or to develop new skills (Linnenbrink and Pintrich 2003). It is more beneficial to have self-efficacy beliefs that are relatively accurate or calibrated to actual accomplishments (Bandura 1997). This implies that teachers should attempt to foster positive, but accurate, self-efficacy beliefs in their students.

Based on the research that has been reviewed here, it is clear that efficacy plays an important role in students’ engagement with classroom material. Thus, it is worthwhile to consider the recommendations that have been suggested for teachers to help maintain students’ high, but accurate efficacy judgements. Table 2.3 below encapsulates these suggestions (Pintrich and

### Table 2.3: Recommendations for teachers to facilitate students’ self-efficacy.

<table>
<thead>
<tr>
<th>Recommendations:</th>
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<tbody>
<tr>
<td><strong>Provide genuine opportunities for students to succeed</strong></td>
<td>- Break tasks into smaller, more manageable parts.</td>
</tr>
<tr>
<td></td>
<td>- Provide tasks within students’ Zone of Proximal Development³.</td>
</tr>
<tr>
<td></td>
<td>- Use various evaluation structures.</td>
</tr>
<tr>
<td><strong>Provide accurate feedback to students</strong></td>
<td>- Feedback provided should be specific to the task.</td>
</tr>
<tr>
<td></td>
<td>- Information should be given to the student about his/her skills.</td>
</tr>
<tr>
<td><strong>Foster belief in students that competence and ability is changeable</strong></td>
<td>- Reinforce the idea that something (e.g. science) is learnable.</td>
</tr>
<tr>
<td></td>
<td>- Explain the role of effort and learning strategies.</td>
</tr>
<tr>
<td></td>
<td>- Communicate high, yet realistic, expectations of students.</td>
</tr>
</tbody>
</table>

Teachers can help students to maintain high self-efficacy levels by assigning appropriately challenging tasks, so that students can achieve them with effort, by fostering the belief in students that science, and other subjects, are indeed learnable, and by supporting students through positive, task-specific feedback.

In summary, self-efficacy plays an important role in student motivation in the classroom. Students who have high self-efficacy beliefs will more likely be engaged in the classroom, in terms of their behaviour (expending effort and willingness to persist at tasks), cognition (will be more thoughtful and reflective while doing schoolwork) and motivation. Students’ self-efficacy is inherently changeable and sensitive to contextual features of the classroom. Hence, teachers can design and organise their instruction to have a positive impact on student self-efficacy and, in turn, on student motivation in the classroom.

### 2.3.5 Conclusion

The basic needs of autonomy, competence and social belonging can all be met in a classroom that emphasises exploration, understanding and communication instead of rules, routines and rote learning (Hannula 2006). However, if educators want to create these types of environments recommended by motivation researchers, they will have to navigate through the

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³ The Zone of Proximal Development (ZPD) relates to the gap between what a learner has already mastered (the actual level of development) and what he or she is capable of achieving when provided with educational support (potential development).
external demands of education (standardised testing, large class sizes, textbooks that promote shallow levels of understanding), which may undermine these efforts and also receive training in how to create mastery-goal structures, autonomy-supportive learning environments, and genuine opportunities for success for their students (Urdan and Schoenfelder 2006).

It is now clear from the literature review that academic motivation is multiply-determined and reflects a complex interaction of many personal and situational factors. Many of these factors are out of the control of the teacher. The few situational factors in schools and classrooms which determine students’ academic motivation have been the focus of this chapter, namely: helping students to feel competent, viewing learning as a process rather than an end, and meeting the social-relational needs of students. In conclusion, enhancing student motivation in schools requires attention to the features of the learning environment, both social and academic, that affect motivation and a willingness to view motivation as more than just an individual-difference variable.

The following section of this chapter will focus specifically on students’ motivation in science education.

2.4 Motivation in Science Education

Science education does not exist in a vacuum and for it to be properly understood and studied it must be placed in its social, cultural and political context. Two of the main factors that will be explored here, before focusing specifically on motivation in science education, to give insight into the context of science education in Ireland, are that of the role of assessment in teaching and learning and that of careerism⁴.

The first factor that will be discussed, measurement and assessment, forms part of the ‘cultural knots’ of our society, that is, measurement and assessment are part of the deep-rooted ways of thinking and doing that are difficult to challenge and change (Giudici et al. 2001). Exploring this in terms of the education system, it is clear that schools have their own traditions and legacies, their values and ambitions and their accountability to parents and society at large. Against this backdrop many hold a traditional structure where the points-driven examination system appears to reward passive learning, and the mastery and retention of material in an uncritical fashion (DES 2006).

⁴ Careerism here relates to the investment in education for economic growth.
It has been suggested that the major purpose of assessment is to support the teaching and learning process (Gipps 1994) but the more widespread view is that assessment is the factor that dominates teaching and learning (Callan 1995). In fact, as far back as the 1980’s it was believed that assessment was ‘the tail that wags the curriculum dog’ meaning, what is assessed is what gets taught, which becomes or defines the curriculum (Hargreaves 1989).

With regard to the Irish education system a large scale study carried out in 2009 by the Teaching and Learning International Survey (TALIS) (which is a project commissioned by the OECD) found that teachers in Ireland tend to support constructivist beliefs about teaching (e.g., they view their role as facilitator of active learning by students) to a lesser extent than teachers in Austria, Denmark, Belgium (Fl), Norway and Poland (OECD 2009). Conversely, teachers in Ireland hold stronger direct transmission beliefs (e.g., they see their role as transmitting knowledge, and providing correct solutions) than teachers in these countries (ibid, p 3). Furthermore, an earlier extensive international study by the OECD showed that within Irish classrooms there is an absence of non-instructional forms of learning, an emphasis on competitive assessment and structuring of lessons around textbooks (OECD 1991). These are still the defining features of Irish education in both the junior and senior cycles.

Assessment reformers today emphasise the need for a closer substantive connection between assessment and meaningful instruction (Shepard 2000). Such reformers are reacting against documented distortions of assessment in recent decades, where teachers, in the contexts of high-stakes examinations, have reshaped instructional activities to conform to both the content and format of external standardised tests (ibid). This position is reiterated in Smyth and Banks’ study (2012) in Ireland where they found that the emphasis on examinations and assessment ultimately encourages teachers to ‘teach to the test’.

As will be discussed later in this chapter, assessment is an area of the science curriculum at junior cycle level that is under reform with more increased emphasis being placed on assessment for learning, continuous assessment and project work. The main idea of the reform is to phase out the exclusive use of large-scale state examinations, the Junior and Leaving Certificate, and to focus on student learning for the 21st century.

The second factor under review here is that of the role of investment in education for economic growth. In order to fully understand this phenomenon it is important to give a brief overview of the history of the education system in Ireland.
One of the most dominant and significant factors on the Irish education system has been the Catholic Church, which has played an influential role on the Irish education system since the 1920s. Until recently the Catholic Church has exercised strong control of education at both primary and post-primary levels. After the establishment of the Republic of Ireland as The Free State, schools were used by both political and church powers to cultivate a particular, one-dimensional type of nationality, culture and religion (Farren 2002). This influence affected not only the curriculum but also how schools were managed. Farren relates, for example, the church’s reluctance to change the managerial system of national schools in the 1940s to the point of frustrating departmental efforts at improving school buildings, many of which were in dire need of restoration (ibid).

However, the government did take a stand against the Catholic Church when they authorised a comprehensive evaluation of the Irish educational system by an independent survey team, the OECD, in the 1960s. The survey team presented a wide-ranging and highly critical analysis of the educational sector, based on the accumulation, for the first time, of comprehensive statistical data about education in the Irish state (Walsh et al. 2014, p. 119).

*Investment in Education* was the product of the study initiated by the OECD. It was a report published in 1965 which illustrated the traditional shortcomings of the educational system – from curriculum limitations to ineffective use of resources to severe disparities in participation linked to class and region – in such a definitive fashion that political and administrative elites were obliged to confront them effectively for the first time since the foundation of the state (ibid, p. 119).

Now, *Investment in Education* has come to be regarded as a major modernising influence in Irish society. It is credited with rescuing Irish education from its concern with character development and religious formation, pursued through the medium of a general education largely comprised of literary and classical studies (O’Sullivan 2005, p. 129). *Investment in Education* brought about the increasing recognition that funding education was an investment that would contribute to economic expansion; it also reconceptualised education as a social institution and directed attention to the imperative that schools respond to the technological requirements of industry (ibid, p. 129).

As Ireland developed, one of the key challenges identified for education was to develop the necessary mix of creativity and skills to respond to the needs of a changing labour market. Areas of education that received much focus were that of mathematics, physical sciences,
biological sciences, technology and engineering (DES 2004). A number of initiatives were taken by the government to promote these subjects in education, which include, amongst others: a revised science curriculum at primary level introduced in September 2003; revised syllabi in junior and senior cycle science subjects from 2000 onwards; a Task Force on the Physical Sciences being set up to report to Government in March 2002, setting out a range of recommendations aimed at addressing the declining level of participation in the physical sciences at second level; the funding of Discover Science and Engineering programme and the promotion of an annual Science Week.

It is clear that strengthening the quality of science teaching and learning at every level was, and continues to be, an important strategic goal for the education system in Ireland.

Looking now more closely at motivation in science education, reviews of contemporary science education around the world highlight the current crisis of disappointingly low student enrolments in science courses, and call for major reforms focused on engaging all young people in science learning (Tytler 2007; Osborne and Dillon 2008; Sjøberg and Schreiner 2010). Whilst important, these reviews provide minimal insights into the factors that contribute towards the decline in students’ motivation for learning science. Hence, an evaluation of student participation, achievement and attitudes towards science will initially be outlined in this section of the chapter, in order to provide the context for understanding the factors that affect students’ motivation in science education. Studies that have been undertaken based on students’ motivation for learning science will then be reviewed, before the findings from these pertinent research studies will be explored in detail, offering suggestions for ways to improve students’ motivation in school science.

2.4.1 Are Students Motivated to Study Science in School?
The ability of people to understand the world in which they live and work increasingly depends on their understanding of scientific ideas and associated technologies.

“Education can enable people to make informed choices, empower them to shape scientific and technological developments, and equip them to work in an advanced economy.”

(The Royal Society 2014)

Ireland’s economic future, like many other countries worldwide, depends critically on the supply of an increasing number of people qualified in science and engineering (Task Force
Employment of science, engineering and technology graduates at all levels has been a hallmark of the modern Irish economy, with many of the world’s biggest and most successful companies across a range of industry sectors operating in Ireland, such as Microsoft, Pfizer, Abbott, Boston Scientific, Intel, Google and Facebook. But, unless there is a major national effort to reverse the fall-off, any other money the Irish government spends on attracting overseas investment will go largely to waste, or will have to depend on migrant workers.

2.4.1.1 Student Participation Rates in Sciences

A major source of data, which is regarded as a source of increasing concern, is the data on enrolments to science subjects at upper-secondary level. There continues to be a marked difference in the numbers of students opting for biology than those choosing to study the physical sciences. Highlighting this is a study, which was carried out by the OCED Global Science Forum in 2006, that analysed quantitative trends in science and technology studies over the 1995-2003 period (OECD 2006) across 19 countries. The aim of this study was ultimately to quantify the extent of any decline in student participation rates in science subjects. Results from this study identify a downward trend of the number of students studying science and technology in upper-secondary school, where the proportion of students in the field of the physical sciences and mathematics were particularly affected (OECD 2006). Statistics from national databases reiterate this finding. The proportion of Australian students studying (A-level equivalent) biology in 2009 for instance, was 24.1%, whereas 17.4% chose to study chemistry and a smaller proportion of 14.3% opted to study physics (Office of the Chief Scientist 2012). Similarly, although recorded in a different year, 20.3% of English students decided to study biology for their A-levels in 2014, 17.1% studied chemistry and 11.9% chose to study physics (Department for Education 2014). Irish second-level students’ uptake of science subjects for upper-secondary study reflects this trend, as evident in Figure 2.2.
What is unusual about the trend in student participation rates in science in Ireland is the substantial gap between those studying the physical and agricultural sciences (~15%) and those studying biology (~60%). The proportion of students opting to study biology in other countries, after the compulsory period of study, is not as large. When the uptake of the science subjects in Ireland are displayed against the backdrop of all optional subjects for Leaving Certificate\(^5\), it is clear that in fact biology is the most popular optional subject chosen by Irish students for further study in upper-second-level (see Figure 2.3).

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\(^5\)The Leaving Certificate is a state examination in Ireland and is equivalent to the UK’s A-levels.
Figure 2.3: Participation rates of all optional Leaving Certificate subjects in Ireland in 2014.

Figure 2.3 illustrates students’ choice in the uptake of various subjects for study for the Leaving Certificate examination. The uptake of all science subjects, with the clear exception of biology, is relatively low. This perhaps reflects students’ perceptions of the value and or the difficulty of these science subjects.

Although, participation rates are undoubtedly indicative of students’ levels of engagement in science, it must be noted that declining numbers of students opting for any subject do not essentially indicate a declining interest in that subject (Matthews 2007). Osborne et al. (2003) reinforce this point in stating that any attribution of significance to enrolment data alone as a sole measure of interest in various science domains is questionable. Students choose examination subjects for many reasons. Subject choice can be highly affected, for example, by “changes in society that affect the structure of economic opportunities, the desire not to foreclose opportunities, the perceived difficulties of the subject and, particularly in the case of boys, the association of subject with gender identity – all of which may be very well independent of interest in science” (Osborne et al. 2003, p. 11).

Moving on from this, it is clear that not only is the quantity of students participating in the science subjects important for understanding students’ motivational orientations, quality is...
also a significant variable. Thus, the following section will explore students’ achievement in science with a particular focus on Irish students’ achievement levels.

2.4.1.2 Student Achievement in Science

The relationship between motivation and achievement is a key issue permeating much of the science motivation literature. Rather mixed views have been reported on the strength of the relationship between motivation and achievement in science. In terms of the motivational variable interest, for example, the link between students’ interest in science and their motivation is stated by Schibeci (1984) as having a strong link (based on studies which show a high correlation of 0.3 to 0.5). Likewise, the measures used in the TIMSS study have found a consistent relationship between student attitude towards science and science achievement (Beaton et al. 1996). On the other hand, Weinburgh’s (1995) meta-analysis of research suggests that there is only a moderate correlation between students’ interest in and attitudes towards science and their science achievement.

Apart from the possible causal link between motivation and achievement however, it must also be acknowledged that education systems have long been predicated on the idea of academic ability, as mentioned previously. The focus in education generally, and science education more specifically, has been on assessment, on the outcomes of education as opposed to the processes of learning. With this in mind, it can be reported that Ireland fairs relatively well in international science achievement comparisons. The results from the PISA studies undertaken over the past number of years highlight that Irish students consistently perform higher than the OECD average. Figure 2.4 illustrates Ireland’s standing in comparison to the highest and lowest scoring countries and the OECD average over the past three international PISA assessments.
Figure 2.4: Mean scores on the overall science scale for Ireland, the highest, the lowest and the average across OECD countries in 2006, 2009 and 2012.

Ireland ranked 9th highest out 34 participating countries in the PISA 2012 study, edging closer to the highest performing nation, Japan. Further analysis of Ireland’s trends in performance on the PISA science scale shows that while lower achievers in science in Ireland do well, compared to other countries, there is room for improvement among the higher achievers (Eivers et al. 2007).

Furthermore, focusing exclusively on science achievement within Ireland, examination of the performance of Irish students across the main science domains in the 2014 Leaving Certificate provides evidence that, although biology is the most popular science subject chosen for the Leaving Certificate examination, students obtain lower grades in Higher Level biology than they do in Higher Level physics and chemistry (see Figure 2.5).

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Note: This graph includes participating countries only. 30 countries participated in PISA 2006 and 34 in PISA 2009, 2012.
Certainly within the Irish context, achievement is not necessarily indicative of students’ positive attitude towards or interest in a particular subject as biology is by far the most liked science subject, yet the one in which students perform least well. This finding is apparent across many Asian countries also (e.g. Japan, Korea, China and Hong-Kong). Looking at this from a somewhat opposite perspective, results have shown that these Asian countries come out on top in international comparisons on science achievement tests, but lowest on attitude and self-concept scales (Awan et al. 2011). Osborne et al. (2003) agree with this, and contradict to some extent what was reported earlier by Schibeci (1984), in their review of the literature of students’ attitudes towards science, when they conclude that “feelings of enjoyment and interest in science combined with success in junior science courses are likely to lead to a positive commitment toward science which is enduring. Nevertheless, this is only a partial picture and [students] can achieve highly in science without holding a positive attitude towards it” (p.27).

Hence, the final factor that will be explored, in an attempt to provide a comprehensive overview of the context for understanding what influences students’ motivation in science, is students’ *attitude* towards science.

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Figure 2.5: Percentage breakdown of 2014 Higher Level Leaving Certificate candidates by grade (source: State Examinations Commission 2014).
2.4.1.3 Student Attitude toward Science

The relatively low rates of progression in science courses worldwide, once the compulsory period of schooling has ended, have prompted questions about why young people make the decisions that they make, with research on students’ attitudes towards science being one of the main areas in which researchers and policymakers have sought to find answers (The Royal Society 2008).

The concern about the attitudes of young people towards science is not new. The literature on attitudes towards science is extensive, with a first peak of activity in the 1970s and the first half of the 1980s, and an upsurge of interest in the 2000s. A number of clear messages have emerged from much of the early literature in this area:

- Many students are negatively disposed towards school science, perceiving it as difficult and not relevant to their everyday lives.
- Attitudes to school science declines over the years of post-primary schooling, with females more negatively disposed than male students.
- Physical science subjects are less positively perceived than the biological sciences.

(Osborne et al. 2003)

It is interesting to note that more recent studies on students’ attitudes towards science have revealed that students tend to regard science as an important subject in the school curriculum. Results from the PISA 2006 study, for instance, highlight that an average of 93% of students, across the 57 participating countries and economies, agree that “science is important for understanding the natural world”. Furthermore, an equally high proportion of students (92%) in the PISA study reported that “advances in science and technology usually improve peoples’ living conditions”. Jenkins and Nelson’s (2005) research corroborates this finding. In Jenkins and Nelson’s (2005) study, based on students’ attitudes toward post-primary school science in England, 70% of students responded positively to the statement “I think everyone should learn science at school”. Looking at this more specifically in an Irish context, findings from the ROSE report in Ireland and the results from the PISA study in Ireland confirm that, in the main, Irish students also hold positive attitudes towards science in school (Matthews 2007; OECD 2007).

What has been pointed out by Osborne and Collins (2001) and also by Jenkins and Nelson (2005) however, is that the value students place on science in school appears to derive more from perceptions about career benefits than the ability of science in school to engage and
interest them. This assertion is strengthened by the PISA 2006 report which reveals that just over half of the students surveyed internationally (57%) believe that science is relevant to them personally (OECD 2007). Hence, despite the positive attitudes students report having towards science in school, it is clear that many students are ambivalent in relation to how interesting they perceive it to be in school. It is reported throughout the literature that there appears to be a considerable gap between the content of school science courses and students’ interests, particularly for the physical sciences. Matthews (2007) describes in his report, for example, that every student experiences the fruits of pure and applied research in the physical sciences and in technology and engineering to a huge extent in their everyday lives, yet, applications such as televisions, radios, iPods, computers and motor cars go largely unremarked in the science classroom. What is rather worrying in the Irish context is that students’ lowest ratings (of interest) on the content on the lower-secondary science curriculum, given by both girls and boys, are for topics which form major parts of the syllabus (e.g. ‘atoms and molecules’ and ‘electricity’) (Matthews 2007).

Perhaps it should be noted that although the vast majority of the evidence points to the particularly negative responses of students towards physics, this is not the case in Scotland. In fact, for several years physics has been one of the most popular subjects (after English and mathematics), and was the most popular science until 2005 (The Royal Society 2008). Interestingly, a substantially high proportion of physics in Scotland is taught by qualified physicists and using a context-based teaching programme, which may exert a positive influence on students (Reid and Skryabina 2002). In sum however, students’ general preferences for the biological sciences over the physical sciences has not changed since it first emerged in the 1970s and 1980s. In Ireland, this disparity is most marked than in most other countries, as referred to previously.

On a final point, students’ attitudes towards science continue to decline with increasing time in school. Galton et al. (2003) have found that students’ attitudes to school science decline most noticeably in the early years of post-primary education. Bennett and Hogarth (2009) reinforce this point by stating that students aged between 11 and 14 are most susceptible to this decline. Looking at this in an Irish context, a longitudinal study carried out by the ESRI9 into students’ experiences of lower-secondary school in Ireland shows that second year (13-14

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9 The Economic and Social Research Institute is an independent research institute in Dublin. Its research, primarily government-funded, focuses on Ireland's economic and social development to inform policy-making and societal understanding.
years of age) is the **critical point** in Ireland where students either engage or disengage from schooling (Smyth 2009). Smyth’s (2009) findings also illustrate that there are marked gender differences in relation to this critical point, where males tend to disengage more so than females (Smyth 2009). Further research in this area is required in order to determine if this is the case for science in particular or for all subjects in the lower-secondary curriculum in Ireland.

**2.4.1.4 Conclusion**

The importance of fostering future scientists is of fundamental concern, globally, but also more specifically to the Irish government and Irish industries. It must be ensured that potential is not lost in the education system and that capable students are not missing out through lack of opportunity. As discussed, many students do not participate in the sciences beyond the post-compulsory phases of education, particularly the physical sciences. A great deal is still unknown about the characteristics of students who make such choices and the rationale behind their decision-making. The following section will therefore investigate what research has been carried out in this area of student motivation in science, to date, and will offer an overview of the findings of these works.

**2.4.2 What Studies Have Been Carried Out on Students’ Motivation in Science?**

This section reviews the research that has been carried out on students’ motivation in science in school. It provides an overview of some of the studies that have been undertaken in this area in the past 15 years and offers a critical analysis of the methods used in the studies. Firstly, the situation will be explored in an international context, before taking a closer look at the research carried out in this field in Ireland.

**2.4.2.1 International Motivation in Science Education Studies**

Given the global focus on improving student uptake of and achievement in science subjects in upper-second level school, in particular, it is not surprising that a considerable amount of research effort has been devoted to exploring students’ motivation in science in school. The hope has been that the insights yielded will point to possible remedial action.

This section looks at the main features of international work based on students’ motivation in school science, drawing primarily on data gathered in studies undertaken post-2000. A literature review was conducted through electronic databases such as Google Scholar and ERIC using specified search criteria. The search-criteria for the review were defined as follows:
- The title must include the word motivation.
- The title must also include, or make reference to, science as a school subject.
- The study is specific to post-primary school students (incl. middle and high school students).
- The study has been published between the years 2000-2015.
- Journal articles only are considered for review.

This literature review on the electronic databases initially resulted in hundreds of studies. These studies then had to be screened to ensure that they had met the criteria, consequently resulting in 17 studies to be chosen as part of the review. Table 2.4 provides an overview of these studies, including the focus of the research, the method(s) used, the country in which the study was carried out and the age group of the respondents.
<table>
<thead>
<tr>
<th>Name</th>
<th>Year</th>
<th>Author</th>
<th>Focus</th>
<th>Method</th>
<th>Place of Study</th>
<th>Respondents</th>
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</table>
| Motivation to Learn Science: Differences Related to Gender, Class Type and Ability. | 2000 | DeBacker and Nelson   | • Gender  
• Science domain (biological v physical)  
• Goal orientation,  
• Pleasing the teacher  
• Perceived instrumentality  
• Perceived ability | Questionnaire                         | Midsouth USA.  | 10th, 11th, 12th grade students. |
| Learning Complex Scientific Information: Motivation Theory and its Relation to Student Perceptions. | 2000 | Hynd and Sherrie     | • Conceptual change about physics  
• Motivation for biology in college (N/A)  
• Performance | 3 year: Class observations  
Videotaping  
Interviews  
Test data | Georgia, USA.  | 9th, 11th, 12th grade students. |
| Science Enrichment Programs for Gifted High School Girls and Boys: Predictors of Program Impact on Science Confidence and | 2001 | Stake and Mares    | • Learning environment  
• Science attitude | Programme 1 – 4 week summer school  
Programme 2 – 6 week summer school | Midwest (Missouri), USA.  | Highly academic senior high school |
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<td>2002</td>
<td>Singh et al.</td>
<td>Questionnaire</td>
<td>USA.</td>
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<td></td>
<td>• Motivation                                    • Attitude        • Engagement        • Achievement</td>
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<td>8th grade students.</td>
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<td>Learning Environment, Motivation and Achievement in High School Science.</td>
<td>Nolen</td>
<td>Learning environment • Motivation • Learning strategies • Achievement</td>
<td>Summative assessment Student &amp; Teacher questionnaires</td>
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<td>2003</td>
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<td>9th grade students (15 years old).</td>
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<td>Early Adolescents’ Motivation During Science Investigations.</td>
<td>Patrick and Yoon</td>
<td>Learning environment – instructional practice • Conceptual understanding</td>
<td>IBSE intervention Pre/post conceptual understanding test Class observations – videotaped</td>
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<td>2004</td>
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<td>8th grade students.</td>
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<tr>
<td>Students’ Motivation and Learning of Science in a Multi-User Virtual Environment.</td>
<td>Dede et al.</td>
<td>Learning Environments • ICT</td>
<td>Intervention Pre/post questionnaire Pre/post assessment Log files (student work) Interviews Post written assignment Teacher pre/post</td>
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<td>2005</td>
<td></td>
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<td>Middle school students.</td>
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<td>Study</td>
<td>Year</td>
<td>Authors</td>
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<td>Using ARCs model to Promote 11th Graders’ Motivation and Achievement in Learning about Acids and Bases.</td>
<td>2005</td>
<td>Feng and Tuan</td>
<td>Teacher collection of students’ info.</td>
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<tr>
<td>The Dynamics of Motivation and Effort for Classroom Assessments in Middle School Science and Social Studies.</td>
<td>2006</td>
<td>Brookhart et al.</td>
<td>Questionnaire (SMTSL) Pre/post achievement test</td>
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<tr>
<td>Math and Science Motivation: A Longitudinal Examination of the Links Between Choices and Beliefs.</td>
<td>2006</td>
<td>Simpkins et al.</td>
<td>Questionnaire – participation in math and science. Test data.</td>
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<td>Study Title</td>
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● Educational aspirations  
● Class participation  
● Enjoyment of subject. | Questionnaires | Canberra and Sydney, Australia. | 7th, 8th, 9th, 10th, 11th, 12th grade students (middle-class). |
| “I just want the credit!” – Perceived Instrumentality as the Main Characteristic of Boys’ Motivation in a Grade 11 Science Course. | 2008 | Nieswandt and Shanahan | ● Instructional practices  
● Students’ behaviour  
● School ethos | Student and teacher interviews (3 throughout the year)  
Class observations  
Official school documents (mission, website). | Ontario, Canada. | 11th grade students. |
| Uncovering Malaysian Students’ Motivation to Learning Science.             | 2009 | Talib et al.     | ● Factors that influence high achieving science students.  
Student interviews  
Teacher interviews  
Lecturer interviews | Malaysia. | 18-19 year old students of high academic ability (n=25)  
Experienced science teachers (n=4). |
<table>
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<tr>
<th>Study Title</th>
<th>Year</th>
<th>Authors</th>
<th>Methods</th>
<th>Location</th>
<th>Demographics</th>
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● Self-efficacy  
● Self-determination | Online questionnaire  
Student essay assignments  
Student interviews  
Student achievement results | Southeast USA.  
14-18 year old students. |
| Adolescents’ Declining Motivation to Learn Science: Inevitable or Not? | 2011 | Vedder-Weiss and Fortus | ● Goal orientation  
● Engagement in science class  
● Extra-curricular science engagement  
● Perceptions of their schools’ and parents’ goals emphases  
● School type (traditional v democratic). | Questionnaires | Israel.  
5th, 6th, 7th, 8th grade students (with middle-high-socio-economic backgrounds). |
| Gender Differences in Student Motivation and Self-Regulation in | 2012 | Velayutham et al. | ● Self-regulation  
● Gender | Questionnaire (SALES) | Perth, Australia.  
8th, 9th, 10th grade students. |
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<td>Adolescents’ Declining Motivation to Learn Science: A Follow-Up Study.</td>
<td>2012</td>
<td>Vedder-Weiss and Fortus</td>
<td>Learning environment</td>
<td>Questionnaire Interviews</td>
<td>Israel.</td>
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<td>Goal theory</td>
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Note: The table includes a research study focused on adolescents' declining motivation to learn science, highlighting factors such as motivational beliefs, learning environment, goal theory, self-efficacy, and engagement. The study was conducted in Israel and involved 5th, 6th, 7th, and 8th grade students.
What is clear from the studies listed in Table 2.4 is that the majority of research has been carried out in the USA\(^5\) (10 studies). There is a particular lack of research carried out (or published) in Europe, as portrayed in Table 2.4, with other countries such as Canada, Australia, Israel, Malaysia and Taiwan contributing in this field to a greater extent.

The target groups for these motivation research studies were rather evenly matched between middle- (8 studies) and high-school students (7 studies). Two studies focused on both groups of second-level students, including students enrolled from 7\(^{th}\) grade to 12\(^{th}\) grade\(^1\) (Green \textit{et al.} 2007, Bryan \textit{et al.} 2011). All three target groups are of, arguably, equal benefit to the contribution of knowledge in this area. The research that was undertaken with middle-school students (11-16 age range) reflects the perception of this age group as being critical in terms of their declining attitude towards science. On the other hand, the studies that investigate the higher-school students (17-18 age range), those who have decided to continue their studies of science in upper second-level education, are likely to be interested in what factors motivated them to take up these subjects for further study.

Over 80\% of the studies summarised in Table 2.4 concentrated on assessing various aspects of students’ motivation in science \textit{in general} (14 studies). The other 3 studies were interested in specific domains of science (physics/chemistry/biology), and some had a particular focus within that domain (e.g. the topic of acids and bases was the motivation subject being assessed in Feng and Tuan’s (2005) study, as was the topic of biological illnesses in Dede \textit{et al.}’s (2005) study). What is perhaps surprising here is the apparent lack of focus on students’ motivation orientations towards physical science subjects in particular, as attitudinal surveys spanning over three decades have shown that attitudes towards the physical sciences are much more negative than the biological sciences (see, for example, Gardner 1975; Kelly 1986; Osborne \textit{et al.} 2003).

In relation to the constructs that were measured, as indirect measurements of motivation, learning environment and achievement were the two aspects that featured most prominently. Other constructs that also emerged as characteristic measurements were those of goal orientations, attitudes and learning strategies.

\(^5\) For clarity purposes, the student motivation studies that will be discussed here will focus solely on those as outlined in Table 2.4.

\(^1\) The following table, Table 2.5, provides an overview of the various secondary school structures employed in many of the different countries related to the studies in Table 2.4.
It is evident from Table 2.4 that the most common method of measuring motivation in the studies listed was through the use of self-report motivation questionnaires (13 studies). Furthermore, the use of more than one instrument/method was common among these studies, which enabled the triangulation of findings. A mere 3 studies, out of the total of 17, however, relied predominantly on qualitative methods of data collection (Hynd and Sherrie 2000; Nieswandt and Shanahan 2008; Talib et al. 2009).

Before exploring the findings of these studies and unearthing possible factors that affect students’ motivation in science, it is worthwhile to consider both the advantages and disadvantages of the various methods used to measure students’ motivation in science.
Table 2.5: Overview of the post-primary school structures employed in Ireland, Scotland, England, Wales, Australia, Canada and the USA.

<table>
<thead>
<tr>
<th>Country Grading System: Ireland &amp; Scotland.</th>
<th>Typical Age (Years)</th>
<th>Stage in School</th>
<th>Country Grading System: England, Wales, Australia, Canada &amp; USA.</th>
<th>Typical Age (Years)</th>
<th>Stage in School</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ireland</td>
<td></td>
<td></td>
<td>England &amp; Wales</td>
</tr>
<tr>
<td>1st Year</td>
<td>12-13</td>
<td>Junior Cycle (JC).</td>
<td>Grade/Year 7</td>
<td>11-12</td>
<td>Key Stage (KS) 3.</td>
</tr>
<tr>
<td>2nd Year</td>
<td>13-14</td>
<td>JC.</td>
<td>Grade/Year 8</td>
<td>12-13</td>
<td>Middle School (MS).</td>
</tr>
<tr>
<td>3rd Year</td>
<td>14-15</td>
<td>JC. Junior Certificate Examination</td>
<td>Grade/Year 9</td>
<td>13-14</td>
<td>KS 3. SAT Examination.</td>
</tr>
<tr>
<td>5th Year</td>
<td>16-17</td>
<td>Senior Cycle (SC).</td>
<td>Senior Phase (SP). Higher Examination.</td>
<td>Grade/Year 11</td>
<td>KS 4. GSCE Examination.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Senior Secondary School (SSS).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>School Leaving Certificate.</td>
</tr>
</tbody>
</table>

Year 13 (England & Wales only) 17-18 KS 5. A-Level Examination.
2.4.2.2 Methods of Measuring Motivation

Much of the curiosity surrounding students’ motivation in general, but in science education more specifically, focuses on the actual measurement of motivation. Recognition of the difficulty of measuring motivation comes in both the diversity and quantity of existing motivation instruments. With that being said, attempts to measure students’ motivation in science have, in the main, shown a strong reliance on quantitative methods (Osborne et al. 2008; The Royal Society 2008), as is evident in the studies recorded in Table 2.4. This measurement technique permits the efficient gathering and analysis of large-scale datasets. It allows for the relative straightforward comparison of motivational orientations across age groups, developmental levels and gender (Fulmer and Frijters 2009). However, what this leads to, in many cases, is that researchers take an ad hoc approach to the use of existing published, and non-published, questionnaires, incorporating only specific subscales or items of a measure (Fulmer and Frijters 2009). Moreover, some researchers also change scales in such existing questionnaires to correspond with a different subject area of concern to them. For example, Pintrich et al.’s (1991) well-known Motivated Strategies for Learning Questionnaire (MSLQ), which is intended to assess college students’ motivation towards learning in general, is often adapted for use with middle- or high- school students and/or for particular subjects, as is the case in Tuan et al.’s (2005) and Brookhart et al.’s (2006) works, to name but a few. Table 2.6 illustrates the main motivational tools that were regularly used directly, or adapted for use, in science motivation studies.

There are many advantages of using self-report questionnaires in measuring students’ academic motivation in science. The psychometric benefits of well-constructed self-report measures are high internal consistency and specificity in construct definition (Marsh et al. 2003). Self-reports also have advantageous scaling properties suitable for the use of inferential statistics, allowing for standardisation and straightforward statistical analysis (Elliot 2004). On the other hand however, there are several widely recognised weaknesses of self-report questionnaires that warrant attention, namely construct definition, developmental and measurement/reliability issues (Kieth and Bracken 1996; Elliot 2004). These weaknesses are discussed below.

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12 Motivation, as described previously, has been partitioned into several dimensions and constructs. The operationalisation and definition of motivation and constructs involved continue to be debated.
**Construct Issues**

Due in part to continued debates regarding core motivational concepts and an absence of clear operational definitions, confusion over the distinction between terms and inconsistent conclusions regarding motivational concepts persist (Keith and Bracken 1996; Murphy and Alexander 2000; Bear *et al.* 2002). A number of self-report questionnaires consider motivation from a single theoretical perspective, oversimplifying the complexities of motivation and resulting in a lack of understanding of the conceptual difficulties within this construct (Elliot 2004). For example, studies that focus predominantly on students’ interest in or attitudes towards science (e.g. TIMSS, ROSE, PISA) as a measure of motivation fail to consider other significant aspects of motivation such as students’ needs (according to the SDT) and goals.

Additional issues arise with regard to the confusion in motivation terminology. Similarly named subscales across different measures often appear equivalent in various questionnaires but do not always cover similar domains (Bear *et al.* 2002; Marsh *et al.* 2003). Bong’s (1996) statement highlights that “many researchers are too quick to invent their own set of labels without carefully
### Table 2.6: Frequently used self-report motivation questionnaires in science education.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Author(s) and Year</th>
<th>Domain and Methods</th>
<th>Respondent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multidimensional Motivation Instrument</td>
<td>Uguroglu et al. 1981</td>
<td>1. Social, emotional and physical self-concept&lt;br&gt;2. Locus of control&lt;br&gt;3. Achievement</td>
<td>Primary- and second-level students (Grades 3-8).</td>
</tr>
<tr>
<td>Children’s Science Curiosity Scale (SCS)</td>
<td>Harty et al. 1984</td>
<td>Likert-scales. Science engagement, interest, attitude.</td>
<td>Primary school students (5th grade).</td>
</tr>
<tr>
<td>Patterns of Adaptive Learning Survey</td>
<td>Midgley et al. 2000</td>
<td>Composed of teacher scales and student scales.</td>
<td>Primary and second-</td>
</tr>
</tbody>
</table>
### (PALS)

**Student scales:**
1. Personal achievement goal orientations
2. Perception of teacher’s goals
3. Perception of classroom goal structure
4. Academic-related perceptions, beliefs and strategies.
5. Perceptions of parents, home-life and neighbourhood.

**Teacher scales:**
1. Perception of the school goal structure for students
2. Approaches to instruction
3. Personal teaching efficacy.

|-----------------------------|----------------------|----------------------------------------------------|------------------------|
| **Student Motivation in Science Learning Questionnaire (SMTSL)** | Tuan *et al.* 2005 | Likert-scales composed of 6 subscales: 
1. Self-efficacy 
2. Active-learning strategies 
3. Science learning value 
4. Performance goal 
5. Achievement goal 
<table>
<thead>
<tr>
<th>Questionnaire/Study</th>
<th>Author(s)/Year</th>
<th>Description</th>
<th>Target Audience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Motivation Questionnaire (SMQ)</td>
<td>Glynn and Koballa 2006</td>
<td>Likert-scales composed of 5 subscales:</td>
<td>Third-level students.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1. Intrinsic motivation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Self-determination</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Self-efficacy</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Career motivation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Grade motivation</td>
<td></td>
</tr>
<tr>
<td>Relevance of Science Education (ROSE) 2003</td>
<td>Schreiner and Sjøberg 2010</td>
<td>Science engagement, interest, attitude. Likert-scale and open-response questions.</td>
<td>Second-level students (15 year olds).</td>
</tr>
<tr>
<td>Students’ Adaptive Learning Engagement in Science questionnaire (SALES)</td>
<td>Velayutham et al. 2011</td>
<td>Learning-engagement: Likert-scales composed of 4 subscales.</td>
<td>Second-level students (Grade 8-10).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1. Goal orientation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Task Value</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Self-efficacy</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Self-regulation</td>
<td></td>
</tr>
</tbody>
</table>
examining those found in the literature” which creates “what can be aptly called ‘a conceptual mess’ for those who try to draw a coherent whole out of the relevant literature” (p. 151). Examples of this can be found in DeBacker and Nelson’s (2000) study in which *Pleasing the Teacher* is defined as one of the motivational subscales to be measured. This label creates confusion in that it is synonymous with extrinsic and/or performance goal orientations. Likewise, Glynn and Koballa’s (2006) Science Motivation Questionnaire (SMQ) purports to measure students’ *Grade Motivation*, which appears to be equally similar in meaning to the extrinsic and performance goal orientations as in DeBaker and Nelson’s (2000) work.

A further point with regard to construct issues is that many existing self-report measures of motivation are highly general. This causes concern as a substantial proportion of motivation literature indicates that academic motivation is, in fact, highly differentiated across particular subject areas and situations (Marsh 1990, 1992; Murphy and Alexander 2000; Tuan et al. 2005; Velayutham et al. 2012). This is most apparent in the work that was carried out in the past, whereby instruments were developed by psychologists interested in understanding students’ motivation for general learning, even though that is questionable in itself. These issues still exist however, as many contemporary researchers are both adopting and adapting these scales for use today, for example, scales from the general learning motivation questionnaires: MSLQ (Pintrich et al. 1991) and PALS (Midgely et al. 2000).

**Developmental Issues**

Moving on to the developmental issues in self-report questionnaires, there are the challenges associated with suitable sentence structure and word choice in motivational items or scales (Elliot 2004). Interviews with middle-school students revealed that students regularly experience difficulty understanding common words in motivation items (e.g. improvement) (Karabenick et al. 2007). With reference to the SMQ, as summarised in Table 2.6, it is clear that many of the items in this instrument employ both developmentally inappropriate language and structure, for example: “During the learning processes, I attempt to make connections between the concepts that I learn” (Glynn and Koballa 2006). This is also clear, to a somewhat lesser extent, in the SALES questionnaire, which is comprised of items such as “In this class what I learn satisfies my curiosity” (Velayutham et al. 2012). It is worth noting here that the SMQ tool is used to assess college students’ science learning motivation and therefore, it could be argued that the language used may reflect the increasing maturity and knowledge of older students. However, issues of item interpretation and comprehension are not limited to young students (Karabenick et al. 2007). Karabenick et al. (2007) discuss the
challenges involved in the cognitive processing of self-report items, and in the conceptually abstract terminology included in many of these, and conclude that such measures pose difficulties for both young students and older adolescents to understand. Again, with reference to the work tabulated in Table 2.6, the MSLQ provides another example of scales which use complex wording and often incorporate numerous concepts within the same item e.g.: “The most important thing for me right now is improving my overall grade point average, so my main concern in this class is getting a good grade” (Pintrich et al. 1991).

**Measurement Issues**

Poor construction and limited validation of self-report measures can lead to several psychometric weaknesses (Fulmer and Frijters 2009). For example, items that reference the context of the behaviour as well as beliefs or attitudes about the behaviour may result in inconsistent responses due to the individual participant’s interpretation of different elements of the item (e.g. a PALS item such as “It’s important to me that my teacher doesn’t think I know less than others in the class”, Midgley et al. 2000). Furthermore, the use of many self-report methodologies is based on the assumption that motives are conscious, accessible and can be communicated to others (Murphy and Alexander 2000), even though it is claimed that motivation is based on cognitions and emotions that can only be partially accessed by the individual (Hannula 2006). The work carried out by Karabenick et al. (2007) reinforces this point. The findings from Karabenick et al.’s (2007) interviews with middle-school students illustrate that students also experience difficulty in understanding their own reasons for judging self-efficacy in commonly used items such as PALS (Midgley et al. 2000) and the MSLQ (Pintrich et al. 1991).

A further issue associated with self-report measures of motivation is that motivation questionnaires often generate data that lack contextualisation and interpretation (The Royal Society 2008). It is widely suggested that, despite efforts of various approaches to encapsulate the construct of motivation, a single approach is unable to capture its complexities (Fulmer and Frijters 2009). Consequently, there have been some attempts to augment questionnaire data, as shown in Table 2.4, through interviews, focus groups and classroom observations. These approaches are more labour-intensive, but have the advantage of being able to probe for explanatory data (Bennett et al. 2006).
2.4.2.3 *Alternative Methods of Measuring Motivation*

Qualitative approaches to the measurement of motivation are becoming increasingly popular. It is believed that qualitative measures provide more depth to the evaluation of motivation because they are based on students’ own constructions of experience and emphasise idiographic\(^\text{13}\) patterns of motivation (Shedivy 2004), rather than the description of broad patterns or correlations across many students (Fulmer and Frijters 2009). The fundamental difference between a qualitative focus and a quantitative focus in data collection is that student-derived versus researcher-derived categories are the primary unit of analysis (Shedivy 2004). In other words, in the qualitative approach, *items* are not usually constructed by the researcher to which the student indicates agreement or degree of endorsement; rather, meaning emerges from the students’ experience of motivation and their language for articulating the experience.

Advantages of the qualitative method (interviews, focus groups, classroom observations) over the quantitative method (mainly self-report questionnaires) include the ability to interpret and integrate multiple factors that influence motivation, recognising motivation as a process rather than a state that can be measured by a questionnaire at a single point in time (Dörnyei 2000). In this way, methods such as interviews and student focus groups introduce a wide range of meanings for human experience, potentially approaching the complexities of motivation more satisfactorily than the self-report method (West 2002).

Limitations of these qualitative approaches include the notion that analysis is subjective and interpretative, and not isometric with empirical objective methods such as self-report questionnaires (Fulmer and Frijters 2009). Furthermore, findings from such methods only apply to the particular participants involved, limiting the generalisability of the results (Spinelli 1989).

It should be noted that qualitative methods share limitations with the self-report method. For instance, it is assumed in qualitative methods that students can consciously assess and explain their motivation; yet, it is understood that motivational behaviours are influenced by unconscious drives and needs (Dörnyei 2000).

In addition to this, qualitative methods have been criticised for an overdependence on verbal descriptions (Spinelli 1989), which is problematic when considering the lack of correlation

\(^{13}\) The term *idiographic* relates to the study or discovery of particular scientific facts and processes, as distinct from general laws.
between individuals’ attitudes and their actual behaviour (Brehm and Self 1989). Although the developmental ability of students to reflect on their motivation states and experiences may be considered a limitation of qualitative methods, the researcher may overcome this challenge, in some respects, by developing skills to structure an interview and an atmosphere that will elicit students’ narratives of their experiences (Fulmer and Frijters 2009).

On a final note, a further novel method of measuring motivation, which has been proposed in the literature, is that of neuropsychological measurement. The focus of this approach is to measure neural specificity for different aspects of motivation states and influences (Taylor et al. 2004) using brain imaging tools and eye trackers. It is clear however, that this method requires high-technology equipment, specialised personnel to undertake the measurement and unnatural settings for willing student participants, among other limitations.

In sum, measures of motivation should ideally be multidimensional in both theoretical perspectives and measurement techniques, reflecting multiple perspectives and approaches to capture the complexities of students’ motivational profiles with regards to science in school. Although integration of methods is challenging due to diverse definitions of motivation and instruments that measure different aspects of motivation, it is essential if the study of students’ motivation in science is to be advanced.

2.4.2.4 Student Motivation in Science Studies in Ireland

To date, as far as the author is aware, the only middle-large scale assessments of students’ motivation to study school science in Ireland have been carried out by large international comparative studies such as PISA (OECD 2007), TIMSS (Martin et al. 2012) and the ROSE project (Schreiner and Sjøberg 2010). Exceptions to this are the Task Force on the Physical Sciences14 (2002) and the ESRI’s study on Irish students’ experiences through second-level school (Smyth and Calvert 2011). Both of these studies concentrate specifically on issues in Ireland. However, their predominant focus is on students’ interests and attitudes towards science (and other school subjects in the case of Smyth and Clavert’s (2011) work), rather than students’ motivation in science (Task Force 2002).

In addition to this, there have been numerous EU-FP7 funded projects recently carried out in Ireland on Inquiry-Based Science Education (IBSE). They include: TEMI (Teaching Enquiry with Mysteries Incorporated), ESTABLISH (European Science and Technology in Action:

14 The Task Force on the Physical Sciences was established by the Irish Minister for Education & Science in order to address the declining uptake of the physical sciences in Ireland and the related issues.
Building Links with Industry, Schools and Home), **SALIS** (Strategies for Assessment of Inquiry Learning in Science), **PROFILES** (Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science), **PATHWAY**, **Fibonacci**, and **CHREACT** (Chain Reaction: A Sustainable Approach to Inquiry-Based Science Education). Each project addressed specific aspects of IBSE, ranging from the effective implementation of inquiry to the assessment of inquiry.

The impact of IBSE was investigated in a pre-post test design only in the PROFILES and SALIS projects by means of the MoLE instrument, an instrument designed to assess students’ motivation in science. Results from the PROFILES project revealed that the students’ (intrinsic) motivation to learn science increased while they were taught by means of PROFILES type modules and/or by the PROFILES IBSE oriented approaches (Bolte and Rauch 2014). These results are reflective of those obtained from the Irish partner in this project, University College Cork (ibid). Similarly, it has been reported that the SALIS project was “highly successful” as “students assessed [the] project courses as relevant, popular and highly (intrinsically) motivational” (Bolte and Streller 2012, p. 13).

Otherwise, there is very little evidence of the effect these heavily-funded, large research projects are having on students’ motivation in science. More work has to be done in coordinating, collaborating and comparing the findings from these projects.

In essence, it is quite clear that there is a need for in-depth research into Irish students’ motivational states and orientations towards science in school. As discussed at length, motivation is both content- and situation-specific, and hence, students’ motivation profiles in other European countries or in the USA for example, cannot be assumed to reflect Irish students’ motivational states.

Findings that shed light on the situation in Ireland (e.g. ROSE, TIMSS, Task Force, etc., and which have been alluded to previously) will be discussed in greater detail in the following section.

### 2.4.3 Influences on Students’ Motivation in Science

This final section of the literature review chapter will report on the findings of studies based on post-primary school students’ motivation in science. What certainly emerges from the research in this area is that more than one influence is identified when describing factors that affect students’ motivation. The layout of this section will follow the same as that in section
2.3 where the influences of goals, the learning environment, task value and self-efficacy on student motivation in science will be explored in detail. Achievement will also be discussed in light of relevant findings in the literature. Finally, the implications of these findings on practice will discussed, before concluding the chapter as a whole.

2.4.3.1 Factors Influencing Students’ Motivation in Science

Goals
It has been widely documented that mastery goals are usually what are valued in students’ learning motivation. However, a number of studies have stressed that performance goals (e.g. trying to do better than others, believing that ability is the primary determinant of successful performance) could have positive effects on achievement (Harackiewicz et al. 1997; Harackiewicz et al. 1998; Hidi and Harackiewicz 2000). DeBacker and Nelson (2000) elaborate on the potential merits of holding a performance-orientated approach by explaining how students will unavoidably encounter aspects of instruction in science, as in all domains, that are not intrinsically motivating to them. When this occurs, the students’ willingness to engage in learning may be highly determined by their desire to earn positive recognition, the extent to which they see the task as related to valued future goals, or their desire to please their teacher.

Hynd and Sherrie (2000) elaborate on this by stating that extrinsic motives may not have a negative impact on students’ motivation in learning physics. Hynd and Sherrie’s (2000) results reveal that successful students in the physics classes in their research study did not view grades as merely external rewards, but saw them as a way to meet their future goals (to get into college and pursue a career) as well as to provide a measure of how well they were living up to their own expectations. Good grades, it was reported, made the students feel that they were reaching their potential and moving forward in life (ibid). In this sense, grades became motivators that were related to students’ self-efficacy, which will be discussed at a later stage.

Research has shown that the degree of endorsement of mastery and performance goals is strongly related to characteristics of the learning environment (Ames and Archer 1988). Ames and Archer (1988) suggest, among others, that classrooms which promote the adoption of mastery goals share several characteristics: (a) instructors emphasise strategy use and effort, not ability; (b) students are encouraged to gauge their progress against their own past performances; and (c) grades and social comparisons are de-emphasised. By emphasising
strategy use and effort, teachers facilitate a sense of control in students over their own learning. That sense of control is particularly important for students who struggle at school and are at risk of developing learned helplessness, the sense that they are helpless in the face of academic failure. The sense of control is heightened when students develop the habit of noting their own progress and attributing progress to effortful use of effective learning strategies.

Moreover, DeBacker and Nelson (2000) note that in classrooms where attention is deflected away from public evaluations of performance (e.g. student grades are not posted or otherwise publicly available or comparisons of academic performance among peers is discouraged), students are less likely to become ego involved\textsuperscript{15} in their school science performance. When students become ego involved and are not confident of success, they may respond by avoiding challenging tasks or by setting unrealistically high goals. Through these means students are able to avoid negative judgements of others but only at the expense of lost learning opportunities (\textit{ibid}).

In terms of gender-related differences that are reported in the literature, boys appear to be more strongly performance-orientated and more dominant in small-group activities than girls (Patrick and Yoon 2004). Patrick and Yoon’s study on early adolescents’ motivation in science in Chicago schools raises the question about the extent to which boys’ typical greater competitiveness and dominance are likely to contribute to girls’ discomfort in small-group inquiry activities, and thus, potentially detract from girls’ learning (see Inzlicht and Ben-Zeev 2000). This will be explored in more detail when discussing the influence of self-efficacy on students’ motivation in science.

Other ways in which students’ motivation in science is influenced by goal orientations is in their adoption of certain goals as communicated by the school culture as a whole. It has been suggested that school culture influences students’ motivation both indirectly, by affecting their teachers’ instruction, as well as directly by conveying effective messages beyond those delivered by the teacher in the classroom (Eccles \textit{et al.} 1993; Kaplan and Maehr 1997; Boaler 2002). In a study carried out in Israel comparing students’ motivation to learn science in

\footnote{\textsuperscript{15} Ego involvement focuses students’ attention away from a learning task and onto their need for approval and social acceptance.}
democratic schools against those in traditional schools, it was found that the goal structures set up by the various schools had a powerful influence on the goal orientations that the students adopted. The democratic school emphasised mastery goal orientations, whereas the traditional school valued performance goal orientations. Ron, one of the 7th grade students who was interviewed in Vedder-Weiss and Forus’ (2012) study, who moved at the beginning of the school year from a traditional elementary school to a democratic school, said that “last year (at the traditional school) success was to get a good grade in a test, to do a lot of homework…and this year (at the democratic school) success is if you learn something new, enrich yourself with something new and interesting”, an answer which clearly reflects a stronger mastery goal orientation at the democratic school.

Other evidence that illustrated the powerful effects of the goals of certain schools on students’ motivation to learn science is that of Nieswandt and Shanahan’s (2008) study. This study focuses on a group of students who are perceived as lower in status and ability and who were attending a prestigious Canadian high-school which has a strong academic reputation. It is clear that the students in this study internalise the goal messages in the school, which ultimately position them in an “E-E type of instrumentality”, the most externally controlled type of extrinsic motivation. It was not made explicit what the students’ goal orientations were before the study began, or before they started their education in this particular school. What was reported was that the resulting motivation levels of the students in question were very low and were mostly performance-orientated.

The influence of family on students’ goal orientations is another important factor affecting students’ motivation in science (Talton and Simpson 1986; Kelly 1988; Baker and Leary 1995). Results from Stake and Mare’s (2001) study based on gifted high school students’ confidence and motivation in an extra-curricular science enrichment programme, corroborates this theory. Their results suggest that students who went home to interested, supportive families were able to benefit more from the programme. Interestingly, the social status of the family, as measured by the parents’ education, was not related to these benefits. They conclude that it is not the general advantages associated with well-educated parents, rather,

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16 The most apparent difference between Israeli democratic schools and traditional schools is that students are allowed to make more choices about their learning in the democratic schools. They may choose what subjects they will learn, and to some extent, with whom and how much they will learn.

17 E-E stands for extrinsically motivated and externally regulated, the most externally controlled type of motivation according to Ryan and Deci’s (2000) Self-Determination Theory.
positive family attitudes about the value of science and science careers, which helped students to maximise their experience in the science enrichment programme.

Moreover, in Hynd and Sherrie’s (2000) study investigating high-school students’ motivation in studying physics, one of the main influences that emerged was “living up to expectations”. The students who were interviewed in this study regularly mentioned that their parents had “inspired” them to study physics. For example, in describing their motivation to study physics one student said that “Well it’s kind of high (her rating) because I know my dad is really determined to make me really good in it, and that kind of makes me go, because I didn’t do so well this semester in here, and then, probably just to make good grades is probably my motivation” (ibid).

Although it has been suggested for a different subject, Friedel et al. (2007) argue that parental influence may in fact be stronger than the school-context influence. To add to this, Maehr (1991) found that the combined effect of family and school on students’ motivation changes with age, as referred to previously. Young students, he suggests, are relatively more influenced by their parents, whereas older students are relatively more influenced by their school. There is conflicting evidence surrounding which influence (parental versus school culture) may have a stronger impact on student motivation in science. It is clear however, that both play a considerable role in affecting it.

**Learning Environment**

Krapp and Prenzel (2011) argue that it is possible to tackle the problem of declining interest and motivation in science, by stating that its development depends on “the quality and type of instruction” (p.35) that is given to students in schools. It is important to consider here, as outlined previously, that motivation is not a stable trait of an individual, but is more situated, contextual, and domain-specific. This suggests that instructional efforts and the design of classrooms and schools can make a significant difference in motivating students (Linnenbrink and Pntrich 2002; Krajcik et al. 2003).

A number of reoccurring themes that emerge from recent work on learning environments are that of the use of context-based teaching approaches, inquiry-based teaching approaches, practical work and ICT resources in the science classroom. These will be discussed in greater detail below.

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18 Friedel et al.’s (2007) study focused on students’ motivation in mathematics, not science.
19 See section 2.3, sub section 2.3.2 ‘Learning Environment – Social Interactions’. 
Context-Based Approaches

Context-based approaches in teaching science, particularly the physical sciences, have been pursued in many countries over the last two decades, including Salters in the UK, ChemCom in the USA, PLON in the Netherlands and Chemie im Kontext in Germany. When compared to conventional courses, these initiatives are more successful in fostering positive student attitudes to school science (Wierstra 1984; Zoller et al. 1990; Zoller et al. 1991; Yager 1993; Key 1998; Barber 2000; Smith and Matthews 2000), in leading to better student understanding of scientific ideas (Yager 1993; Winter and Volk 1994; Banks 1997; Tsai 2000) and also in reducing gender differences in attitudes towards science (Wierstra 1984; Yager and Weld 1999; Smith and Matthews 2000).

As referred to earlier, the applications-led course for Standard Grade physics in Scotland is a clear example, which illustrates the benefits of employing context-based teaching approaches on students’ motivation to study science. The Standard Grade course was initially designed to be a course that could be seen to be both relevant and useful to people in their normal lives. It was introduced in Scotland in the late 1980s, replacing the former Ordinary Grade course. Based on developments in the Netherlands, the Standard Grade physics course was designed as a context-led course where the scientific applications come first, followed by the principles. For example, the operation of an electric motor would be followed by the principles of electromagnetism (McCormick, 2000). In the 2 years following the introduction of Standard Grade physics, there was a sharp increase in the number of students studying physics, for both boys and girls, at the Higher Grade, and, since then, physics has attracted more pupils than chemistry in Scotland at Higher Grade (Reid and Skryabina 2002).

Thus, it appears that the context-based approach is the ideal approach for teaching science in school. Schwartz (2006), however, has highlighted one criticism of context-based education; the concepts may be so closely linked to the issues used to introduce them that the learners do not acquire the ability to generalise and transfer those ideas. While there is much evidence to support the view that context-based approaches are effective in motivating learners and enhancing their attitudes towards science, there is also some evidence to suggest that such approaches can adversely affect learners’ understanding of scientific ideas (Ramsden 1997; DeJong 2007).

Looking at this from an Irish perspective, only one small scale study has been conducted in Ireland on the effects of implementing context-based or STS (Science Technology and
Society) approaches on the teaching of science in second-level schools (Smith and Matthews 2000). Furthermore, there has been little systematic research on science teaching methods employed in Irish post-primary schools but existing evidence points to the dominance of more didactic approaches (Gilleece et al. 2009).

The context in Ireland is changing however. The Department of Education and Skills (DES 2012), drawing on work by the National Council for Curriculum and Assessment (NCCA 2011), have proposed changes to lower-secondary schooling that would see emphasis shift from summative assessment and didactic teaching approaches to more student-centred pedagogical approaches, with greater use of formative assessment. The framework will also focus on six key skills that have been identified as important skills for 21\textsuperscript{st} century learning and living. These include:

- Managing Myself
- Staying Well
- Communicating
- Being Creative
- Working with Others
- Managing Information and Thinking

According to the National Council for Curriculum and Assessment (2013), learners will “gradually improve their capacity to search for information from different sources”. They will develop their skills in “judging and discriminating between information types and sources and they will develop strategies for organising information so that they can understand it and use it later”. This new science curriculum is due to be implemented in schools across Ireland within the 2016-2017 academic year.

Inquiry-Based Approaches

Inquiry-Based Science Education (IBSE) is another science teaching approach which has become increasingly popular in recent years. It has been adopted worldwide in the 21\textsuperscript{st} century as one of the main models of science education, particularly in Europe, partly in response to the Rocard Report which outlined “the alarming decline in young people’s interest for key science studies and mathematics” (European Commission 2007, p.2).

IBSE focuses on student inquiry as the driving force for learning, where the teaching is organised around questions and problems in a highly student-centred inquiry
process. In IBSE, students learn through and about scientific inquiry, rather than by teachers presenting scientific content knowledge (National Research Council 2000).

The main advantages of IBSE are that it enhances students' abilities to reason, and to become *independent learners* who are capable of identifying the main questions and find relevant answers (National Research Council 2000). There are some limitations to implementing IBSE however. These include:

- Lack of teacher time.
- Difficult to change teachers’ traditional practice.
- Lack of Continuing Professional Development for teachers.
- Lack of resources.
- Current science textbooks do not reflect IBSE.
- Assessment-driven curriculums.
- Student constraints – ability level, lack of prior exposure to inquiry, lack of cognitive skills and reasoning skills.

(Stake and Easley 1978; Maor and Taylor 1995; Anderson 1996, 2002; SALIS 2012)

As a consequence of the Rocard Report (Rocard *et al.* 2006), the European Union has funded numerous research projects (known as EU-FP7 projects) focused on the implementation of IBSE in schools throughout Europe. A number of these IBSE initiatives have taken place in Ireland. There are 8 ongoing (or recently completed) projects in Ireland on IBSE: TEMI, ESTABLISH, SALIS, PROFILES, PATHWAY, CHREACT, Fibonacci, SALiS, as referred to earlier. The focus of each of these projects has been to emphasise students’ inquiry and problem-solving skills in school science. It is worth noting that no formal coordination or communication has taken place between these projects in Ireland to date. It is thus unclear what impact they have made on students’ motivation to study science in school.

What is clear is that one of the major implications of the new junior cycle course (and similarly proposed new senior cycle frameworks) will be the greater focus on inquiry in the teaching and learning of science in Ireland. But this poses questions relating to the preparedness of Irish science teachers to do inquiry in their classrooms.

Interestingly, despite worldwide investment and heightened emphasis on inquiry-based science education, few large-scale studies have been undertaken that aggregate research findings across individual studies investigating aspects of science inquiry instruction and
resulting student outcomes (Bredderman 1983; Shymansky et al. 1983; Minner et al. 2010). One small scale study that was carried out in Ireland found that the action of inquiry is still very much the exception rather than the norm in Irish classrooms (Lehane 2016). Results from this baseline study reveal that a large majority of second-level science teachers that were surveyed report to giving students step-by-step instructions or carry out scientific procedures themselves when doing experiment work with their students (ibid). This reflects the teacher-led approach to science that has become too familiar in Irish classrooms.

There is no doubt that a great deal more light could be shed on this area if there was more coordination between all of the EU-FP7 funded inquiry projects (as previously referenced) that have been recently undertaken in Ireland and in Europe.

Practical Work
Practical work is often regarded by teachers, and others, as central to the appeal of science (Abrahams 2009; Palmer 2009). Many studies have also shown that students themselves claim to enjoy practical work in science class (Parkinson et al. 1998; Osbourne and Collins 2000,2001; Smyth et al. 2006; Palmer 2009; Swarat et al. 2012). According to Palmer’s (2009) study, in which Grade 9 Australian students’ engagement in an inquiry-based science lesson was investigated, it was found that students were much more engaged throughout the practical aspects of the lesson, such as being involved in experimentation or demonstrations, than the other phases of the lesson including making proposals and writing reports. When Palmer investigated the source of the students’ engagement in these aspects of the lesson, three main sources were identified: novelty, autonomy, and social involvement.

Similarly, in Swarat et al.’s (2012) study, entitled ‘Activity Matters: Understanding Student Interest in School Science’, the effects of learning environment elements (content topic, activity, and learning goals) on middle-school students’ interest in science was investigated. The findings from this study indicated that when judging the interestingness of an instructional episode, students focused primarily on the form of activity rather than the content topic. Activities that were “hands-on” in nature and allowed for engagement with technology elicited higher interest. Students’ preference for activities that actively engage them physically and intellectually is widely recognised (Mitchell 1993; Bergin 1999; Palmer 2009).

Following on from this however, it is interesting to note that when the students’ claims of liking practical work were probed further in Abraham’s (2009) study, it was discovered that in many cases it was not that students actually liked the practical work per se, but merely
preferred it to most alternative methods of teaching science. This is in accord with an earlier study carried out by Hodson (1990), which found that students “regarded practical work as a ‘less boring’ alternative to other methods” of science instruction (p.34).

Exploring Abraham’s (2009) research in more detail, it was found that the students’ claims about liking practical work could be divided up into two different types of claims: those indicative of relative preference (expressing comparative terms such as better than, more than, less than etc.), and those that were termed absolute claims (it was fun, exciting, I liked it etc.). There was a correlation between the use and frequency of the different claims and year group in school. The earlier year groups (i.e. Year 7 with students of 13-14 years of age) tended to like practical work in science class in an absolute sense. By the end of this year, however, this enthusiasm or absolute liking of practical work started to wane. Furthermore, it was observed that the majority of pupils’ claims to like practical work, in Year 8 or above, become statements of relative preference (ibid). This main finding from Abrahams’ (2009) study reveals that students’ views about practical work in science at school move from an absolute liking to a more preferential liking with increasing age/time in school.

It appears that students’ views in Ireland are in keeping with those internationally, where they generally favour “more active learning approaches and lessons which are ‘fun’ and relevant to their lives” (Smyth and Banks 2012). What is of particular interest to note from Smyth and Banks’ study (2012) on Irish student perspectives on teaching and learning, is that many students change their views as they approach the terminal high stakes examination (i.e. the Leaving Certificate), with many showing a strong preference for a more narrowly-focused approach to examination preparation. In Ireland, students experience high stakes examinations twice, as there are two state examinations at age 15/16 and 17/18.

It is likely that as students progress through school the focus on examination performance increases. This certainly impacts on the instructional approaches used by teachers, as referred to previously, in addition to the goals that they communicate, and subsequently, the adoption of these goals by their students.

ICT
Over the past several decades, computer technologies have become an integral part of our society, changing many aspects of our lives including our interactions with one another (Mistler-Jackson and Songer 2000). In Britain (Davis and Pittard 2009; Marshall et al. 2009), Europe (Korte & Hüsing 2006), the USA (Paige et al. 2004) and elsewhere, recent years have
seen a steady embedding of digital and networked technologies in the classroom, with widespread use of interactive whiteboards, virtual learning environments, educational computer games, and increasing reliance on internet applications including email and e-learning for both classroom and independent study (Sheard & Ahmed 2007). With the increasing reliance and investment in ICT in schools, Livingstone (2012) asks the questions:

1. Does the evidence support the claim that ICT enhances learning?
2. What is meant by learning and how are expectations of learning changing?

The use of ICT and new media environments has been reported as an effective way to enhance student interest in science in school (Lepper and Malone 1987; Mitchell 1993; Swarat et al. 2012). It is believed that this type of technology capitalises on the evident enthusiasm with which children use digital technologies for exploration, creativity and fun when at home, encompassing not just ICT-mediated formal educational and information resources but also, indeed especially, the use of instant messaging, online gaming and social networking to foster constructive learning practices, peer collaboration and learner motivation (Livingstone 2012). Furthermore, Livingstone (2012) states that digital technologies can support a more flexible, learner-centered notion of education that facilitates the soft skills vital for the new demands of the 21st-century global service and information economy.

In an American study focused on enhancing middle school students’ motivation and learning about science and society through multi-user virtual environments, Dede et al. (2005) found a number of interesting results. For example, a teacher whose students participated in the study reported that students seem to learn more deeply about science and problem solving in the simulation or manipulation setting through traditional book education, as evidenced by their class discussions (ibid). Furthermore, a number of students themselves reported that it was the first time that they enjoyed science class (ibid). The study also found that the students were fluent in their virtual communication and expression, which undoubtedly reflects the important skills for the 21st century.

Likewise, Liu et al.’s (2011) study, which centred on students’ science learning and motivation in new media enriched environments in the USA, states that popular, emerging technologies are increasingly being used to create learning environments that support students’ curiosity, control and interest within science curricula. Hoffmann and Nadeslon
(2010) claim that utilising new media\textsuperscript{20} applications, which allow students to develop their digital literacy in the classroom while encouraging characteristics of engaged play, might hold potential to increasing students’ motivation in science in school.

From the other perspective however, it seems that a simple increase in ICT provision does not guarantee enhanced educational performance. For instance, an early longitudinal British study, ImpaCT2 (Harrison \textit{et al.} 2003), designed to evaluate the government’s ‘ICT in Schools Programme’, reported that:

“The outcomes of the initiatives are more evident in improvements in pupils’ achievements in ICT capability than in their application of this learning in other subjects”.

(Ofsted 2004, p. 4)

Similarly, a US report to Congress found that test scores in classrooms using reading and mathematics software for a year were little different from those obtained using traditional teaching methods (Dynarski \textit{et al.} 2007). Other obstacles associated with the integration of ICT in education are that:

- It is difficult for teachers to successfully guide students toward the best and appropriate use of ICT tools for measureable content and inquiry gains for all (Mistler-Jackson and Song 2000)
- Teachers can struggle with many management issues when it comes to using ICT in the science classroom: they must tolerate more noise and groups of students performing different activities at different times, and they have a lack of control as to what students are researching (Becker \textit{et al.} 1999).
- There is a challenge of this technology’s initial appeal to aesthetics and novelty. New media science educational designers need to pay attention to developing its capacity to create powerfully engaging interactive experiences that can improve and promote long-lasting learning (Liu \textit{et al.} 2011).

Despite considerable evidence that teachers, along with parents, pupils and other stakeholders believe ICT to improve outcomes, too few independent evaluations comparing educational

\textsuperscript{20} New media refers to content available online, usually containing interactive user feedback and creative participation. Common examples of new media include websites, video games, and social media sites.
settings with versus without an ICT intervention have been conducted, and those that exist are rather equivocal in their conclusions.

In summation, these changes in ICT in education pose both opportunities and challenges to schools, “for to embed ICT in the educational infrastructure, teacher training, curriculum structures and materials, classroom practices and modes of assessment must be redesigned at all levels” (Livingstone 2012, p.10).

Task Value

Despite being surrounded in a school climate saturated with academic competition and performance, it was found in the studies which were reviewed based on students’ motivation in science, that students can shift their motivation from a performance-orientation to a mastery-orientation when they viewed the task as an authentic and meaningful learning experience (e.g. debating and discussing environmental issues) (Nieswandt and Shanahan 2008). Thus, it is important that teachers see the emotional and utility value of the learning task from the students’ perspective, for example, its potential applications outside of the school or examination context (Brophy 1999).

Feng and Tuan’s (2005) study based on Taiwanese 11th grade students’ motivation and achievement in learning about acids and bases, reinforces the point that task value can have a significant impact on increasing students’ motivation levels. They found that their chemistry intervention module on acids and bases was successful in arousing students who had low motivation and interest in learning chemistry.

Furthermore, Velayutham et al. (2012) found that science task value has a statistically significant influence on students’ self-regulation21 in science learning. Self-regulation learning strategies are essential for science achievement, according to the high achieving Malaysian science students in Talib et al.’s (2009) study. In order to perform well in science subjects, the Malaysian students reported that it is necessary to pay full attention in class, consistently revise their science lessons, compile their own short notes, and ask questions in class.

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21 Self-regulated learning emphasises autonomy and control by the individual who monitors, directs, and regulates actions toward goals of information acquisition, expanding expertise, and self-improvement (Paris and Paris 2001).
**Self-Efficacy**

It is widely documented that self-efficacy is an important motivational variable, influencing students’ participation in science, their self-regulatory learning strategies and their achievement. An investigation carried out on the developmental relations between students’ choices and beliefs in mathematics and science, for example, found that students who believed that they were skilled in a particular domain were more likely to pursue this endeavour during adolescence than their peers (Simpkins et al. 2006). In addition, this association emerged as more important than the predictive power of the students’ achievements, parents’ education, and family income (Simpkins et al. 2006). This is not surprising, as one of the major findings from the earliest models of motivation was that when people expect to do well, they tend to try hard, persist and perform better (Pintrich and Schunk 2002).

Data analysed from Velayutham et al.’s (2012) SALES instrument in their study in Western Australia, highlighted that, for both boys and girls (in 8-10th grades), that the most significant motivational belief was that of self-efficacy. They suggest that students who have developed self-efficacy in science learning were more likely to employ self-regulation strategies, such as expending effort on science learning tasks. This is consistent with Bandura’s social-cognitive theory:

> “Efficacy beliefs play a central role in the self-regulation of motivation through goal challenges and outcome expectations. It is partly on the basis of efficacy beliefs that people choose what challenges to undertake, how much effort to expend in the endeavour, how long to persevere in the face of obstacles and failures, and whether failures are motivating or demoralising.”

(Bandura 2001, p.10)

According to Brookhart et al.’s study (2006), they found that self-efficacy was the strongest predictor of students’ science achievement, which is consistent with other work in this area (Pajares and Miller 1994; Lane and Lane 2001; Pintrich and Schunk 2002; Liu et al. 2011). DeBacker and Nelson (2000) explore this phenomenon in more detail, and their findings reveal that higher ability students, physical science students, and male students demonstrate higher scores on perceived ability than lower ability students, students in biological science, and female students, respectively. It has been suggested that perceived ability and academic achievement are reciprocally related so that higher achievement boosts a student’s perceived
ability and the resulting greater confidence, in turn, supports the student in striving for and maintaining high achievement (Bandura 1986). DeBacker and Nelson’s (2000) findings of differences related to achievement level and science class type are consistent with Bandura’s (1986) thinking. However, what is of concern is that girls reported lower perceived ability than boys did, regardless of achievement level and class type (DeBacker and Nelson 2000); their data showed that young female students perceived science as valuable at a level similar to their male counterparts, and they endorsed mastery and performance goals in science to the same extent as male students, yet they reported lower perceived ability in science.

One commonly offered explanation for female students’ lower perceived ability in science is that their confidence is negatively affected by the stereotypical belief that science is a masculine domain. However, that finding is problematic. For instance in the case of DeBacker and Nelson’s (2000) study, girls had lower scores than boys did on stereotyped views of science. Possibly, lower perceived ability in science is just one symptom of the more general lack of confidence that girls are reported to experience during adolescent years (Brown and Gilligan 1992; Orenstein 1994; Pipher 1994).

**Achievement**

In the study carried out by Talib et al. (2009), which investigated the factors that influence high-achieving science students in Malaysia, it was reported that although the responses given by the students, teachers and science experts who took part in the study weren’t very different, the dimensions reported by the students were more likely to include factors external to the student, such as extra classes, family involvement and interaction with others. To elaborate on this, all of the 25 students that participated in Talib et al.’s (2009) interviews referred to family involvement, particularly parental support and participation as being key factors in their achievement in science.

It must be noted that some internal factors were also reported as important for achieving well in science, such as having a positive attitude or interest in science. Interest in science has been described as the “pull” factor, by Talib et al. (2009), which sustains as well as propels science motivated behaviour such as finding additional information from other sources, making sure complex concepts are understood, and learning the necessary terminologies.

**Gender**

As gender is a dimension of almost every variable of motivation it will not be discussed at length here. Rather it has been explored in each section of the literature review where relevant
What is worth exploring further however, is the impact, if any, single-sex versus coeducational schooling has on students’ motivational orientations. This is an area of research that is of increasing interest to education researchers and policy makers; particularly whether or not single-sex schooling yields academic and social advantages for girls and/or boys.

One of the most commonly discussed differences between the two types of settings relates to the dominant presence of boys in the classroom (Smyth 2010). Most studies have indicated that boys contribute more to classroom interaction (for example, by “calling out” answers) and dominate in “hands-on” activities, such as laboratory work and computer sessions (Askew and Ross 1988; Howe 1997; Francis 2004). Furthermore, boys tend to be more disruptive in the classroom and experience more negative interaction with teachers as a result of their misbehaviour (Francis 2000; Warrington and Younger 2000). From this perspective, the presence of boys in the classroom is seen as having a negative effect on girls’ academic engagement and achievement. Other commentators have pointed to the “distraction” inherent in mixed gender educational settings for adolescents. Coleman’s (1961) study pointed to the strong emphasis on “rating and dating” in American high school culture, with peer groups having a negative effect on achievement, especially among girls (see also Riordan 2002).

The Republic of Ireland is one of the few countries in Europe with a historical tradition of single-sex schooling, with single-sex schools still making up over a third of all post-primary schools (Smyth 2010). Single-sex and coeducational schools differ in their intake by social class background and prior academic ability levels. Controlling for these prior differences, a large-scale study carried out in Ireland indicated no significant differences in overall academic achievement between single-sex and coeducational schools for both girls and boys at lower and upper-secondary levels (Hannan et al. 1996).

Other studies have explored self-concept across different subject areas. Sullivan (2009) indicates that the gender gap in self-concepts (with males having higher ratings of their aptitude in mathematics and science, and females in English) is reduced in single-sex settings. Thus, to some degree, single-sex schooling promotes a gender-atypical self-concept and more academically focused girls.

2.3.4.2 Implications for Practice

- In order to better understand adolescents’ distancing from science learning and to be able to offer effective interventions, future research should take into account not only
the teacher and the classroom but also the context in which they operate. Such an approach has been rare in the field of science education (Vedder-Weiss and Fortus 2012).

- To encourage the development of self-regulated learners in lower-secondary science classes, educators must first implement strategies that could effectively increase students’ self-efficacy towards science learning. It is suggested that teachers select pedagogical strategies that are likely to elevate their students’ confidence in science. For example, teachers could tailor science tasks to the abilities of individuals to ensure confidence-building success and to reduce efficacy-diminishing failures (Velayutham et al. 2012).

- Pajares (2008) contends that students who set short-term goals and monitor their progress accordingly are likely to develop stronger self-efficacy than students who have long-term goals. Therefore, teachers could utilise this proposition by encouraging students to set short-term goals for each unit of study, thereby building their competency and confidence in achieving the set goals.

- Talib et al. (2009) emphasise that it is important for teachers to understand what motivates their students. They argue that students, especially those who grasp science subject content easily, if not effortlessly, still need to be motivated to keep them alert and engaged in the class.

2.3.4.3 Conclusions
The teacher’s role has evolved throughout the years. The teacher’s role is no longer solely one of dispensing knowledge and information. Instead, one of the integral roles of the teacher today is to increase students’ motivation and to develop the skills or strategies that could make the student become a self-regulated learner.

The majority of studies carried out in this field emphasise the domain-specific and fluctuating nature of motivation. Varying the setting, the topics, the tasks, and the conditions under which tasks are carried out are central features of the theories of motivation.
Chapter 3: Methodology

“The research community and those using the findings of research have a right to expect that research be conducted rigorously, scrupulously and in an ethically defensible manner. All this requires careful planning, with thought being given particularly to the consequences of the research.”

(Cohen et al. 2000, p. 47)

3.1 Introduction

The main aims and the research questions of this study are outlined in this chapter. The research methods are then explained, as are the advantages of adopting these approaches. This is followed by a review of the methods of data collection, a discussion of how the data was analysed, and a description of the ethical procedures and the limitations involved in conducting this study.

3.2 Aim of the Research Project

The focus of this project is to investigate the apparent decline in students’ motivation to study science in lower-secondary school in Ireland. This study explores the views and attitudes of students themselves in relation to how they perceive their science classes in school, in order to discern what factors motivate them, or equally, what demotivates them, in their learning of science in school. Teachers’ perspectives are also sought about what they think are the influential factors of students’ motivation, as oftentimes, and as explained earlier, motives are not always conscious, accessible nor communicable by the individual (Hannula 2006).

Research Questions

1. Are Irish students motivated to study junior cycle science in school?

2. In what way do junior cycle science students’ motivational orientations differ in the first three years of post-primary education in Ireland?

3. What are the main factors that affect student motivation in junior cycle science in Ireland?

The students referred to here, and from now on, are those studying the junior cycle science course. The reason for focusing on this particular group of students in this study is because
the literature states that it is this group who are most susceptible to experiencing a decline in their motivation to study science. Furthermore, this group of students represent the cohort of students who are about to decide what subjects to chose for further study for their Leaving Certificate examination (senior cycle). The teachers referred to here are teachers who are teaching/have taught junior cycle science.  

3.3 Research Methods

A mixed methods approach was adopted in this study, drawing on both quantitative and qualitative research methods. This was decided upon as an essential approach to studying students’ motivation by the researcher, due to the constraints of adopting a single method for this type of research, as described in the literature review. The following section examines the main differences between quantitative and qualitative research methods, highlighting the advantages and disadvantages of each method. The benefits of mixed methods research are then explored.

Quantitative

“A fundamental goal of research is to generalise – to say something reliably about a wider population on the basis of the findings in a particular study.”

(DeVaus 2014, p.66)

Quantitative research is concerned with explaining phenomena by collecting data that can be quantified and analysed using mathematically based methods (in particular statistics) (Aliaga and Gunderson 2000). Quantitative data may be generated in various ways. Secondary data is data that was generated for other purposes, but which we can be re-used in other work (e.g. secondary data from official statistics or academic sources). Researchers regularly need to generate their own primary data. The most common sources of primary quantitative data are from sample questionnaires (in which a proportion of a population is systematically sampled: a fairly small proportion can give results that are good estimates for the whole population), or censuses of the population (JRC European Commission 2005).

There are considerable advantages to using quantitative methods, which account for the great interest in them. Being able to put information into numerical format means that:

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22 All teachers involved in this study are practicing teachers that have experience teaching junior cycle science. However, some teachers may only be teaching senior cycle classes at present.
• It is possible to manipulate quantitative information in consistent and reproducible ways, combining figures, comparing data, examining trends, etc.
• A considerable amount of data can be collected relatively easily, inexpensively, in a form that can be gathered without the presence of a researcher (e.g. questionnaires).
• The general anonymous nature of quantitative data can be an additional benefit, enabling respondents to be truthful and open in their responses.
• Findings can be generalised to whole populations from a small, representative sample.
• Results can be represented in the form of tables, graphs and charts, which can often communicate the findings very efficiently with people.

(JRC European Commission 2005; Cohen et al. 2007)

Conversely, quantitative research methods also have some limitations. These include:

• Quantitative measurement tools, such as questionnaires, can quite often yield low response rates.
• Some factors cannot be wholly represented numerically, such as many important social and affective variables.
• The quantifiable elements of a phenomenon should not be taken as encompassing of the entire phenomenon, but often they are.
• The connection between research and “real life” can be hindered, where meaning behind events or relationships are ignored.
• The sample may not be representative of the whole population.

(Bryman 2004; Johnson and Onwueguzie 2004; Bell 2005; JRC European Commission 2005; Cohen et al. 2007)

In this study, questionnaires were used to gather primary data from students and teachers based on their perspectives of the influences on students’ motivation to study science in school. Issues relating to the reliability and validity of the quantitative data gathered are discussed under the relevant headings.

Qualitative

In contrast to quantitative research, the intention in qualitative research is not to generalise the information, but to elucidate the particular and the specific (Pinnegar and Daynes 2007). Qualitative researchers seek “insight rather than statistical analysis” (Bell 1993, p.8).
As outlined earlier, and referred to in many instances, qualitative research is an essential aspect of research carried out on motivation. Qualitative research is necessary in this case, according to the researcher, as it gives a voice to the underrepresented groups (i.e. those low or moderate in motivation in school science) and it can probe into a deeper understanding of students’ motivational orientations. It was anticipated that this would lead to specific outcomes such as stories, the essence of the phenomenon and/or the generation of a new motivational theory for junior cycle science students in Ireland.

Furthermore, the focus of qualitative research can be to follow up on existing quantitative research, particularly where this presents findings that need further explanation or where more detail or depth about a phenomenon is required (Kvale and Brinkmann 2009). Qualitative research can also be useful where the group in question appear to have an important perspective on the subject of enquiry that has not been fully explored or explained in the quantitative research (ibid).

Qualitative research is not without its limitations however. The main limitations being that:

1. Qualitative data and analysis is largely subjective and therefore open to researcher bias.
2. Qualitative findings cannot be generalised for a whole population. Rather the findings solely offer insight into the actual participants’ understandings and situations.

The adoption of both quantitative and qualitative methods in this research project will now be explored.

**Mixed Methods**
Both quantitative and qualitative data collection methods were used in this project. Questionnaires (quantitative method) and teacher interviews and student focus groups (qualitative method) were conducted. Different types of methods were used in order to achieve different purposes and methodology literature generally approves of mixed methods:

“If you wish to collect quantitative data you are probably measuring variables and verifying existing theories and hypotheses or questioning them.’ … ‘However, often collections of statistics and number crunching are not the answers to understanding meanings, beliefs and experience, which are better understood through qualitative data.’

(Wisker 2001, p.137)
“It is not clear that quantitative and qualitative research are necessarily incompatible or that one type has a greater claim to truth than the other. Both approaches have helped educational researchers make important discoveries.”

(Gall et al. 1996, p.27)

Some triangulation of the data was performed to “limit the chance of bias in the methods or sources employed” (Grix 2004, p.176). For example, the mix of closed and open questions in both questionnaires permitted some cross-validation of responses. However, often the data obtained from the different methods was not triangulated, because, it was discovered, it was not considering exactly the same phenomena. The different methods were also deliberately employed to collect different data, which would shed light on different aspects of the complex subject of student motivations in science. The summaries that were made of the whole cohorts of student and teacher respondents from the questionnaire data provide a totally different level of detail compared to individuals’ experiences retold in the interviews and focus groups.

3.4 Data Collection and Samples

As stated previously, this research project consisted of two phases. Phase 1 involved the quantitative aspect, with the distribution of a teacher questionnaire and a student questionnaire to a representative sample of schools throughout the Munster region\(^{23}\). The second phase of the project employed a qualitative approach, where in-depth interviews were carried out with a small sample of junior cycle science teachers. In addition, focus groups were conducted with a sample of the student questionnaire respondents from one school.

These two phases are outlined and discussed in more detail below.

**Phase 1: Questionnaires with a Representative Sample of Students and Teachers**

For clarity, this section will be split into sub sections dealing with the teacher questionnaire and the student questionnaires respectively.

**Teacher Questionnaire**

Firstly, the general design of the teacher questionnaire will be explored here. Secondly, the piloting, sampling and ethical considerations will then be discussed, before moving on to review the student questionnaire.

\(^{23}\) The sampling approach adopted for this study will be discussed in greater detail later.
The teacher questionnaire comprised of two sections (see Appendix 1). The first part of the questionnaire gathered generic information from the teachers based on their teaching experience and on the school where they teach. The latter section was designed to address the teachers’ opinions about their students’ motivation in science.

The majority of questions employed in the teacher questionnaire were five-point Likert scale questions. Scales are very useful for the researcher as they “build a degree of sensitivity and differentiation of response whilst still generating numbers” (Cohen et al. 2005, p.253). The limitations and problems of such an approach to data collection are also well-known, and are fully described in the methodological literature (see Oppenheim 1992, Fink 1995, Creswell 2002, Cohen et al 2007). Most obviously, the answers obtained from respondents are determined by the questions presented to them and it is by no means always valid to assume that respondents interpret a question in the way intended by its author (Jenkins and Pell 2006). Beyond this, there is much debate among researchers about the number of choices to be included in a Likert scale (see, for example, Masters 1974; Birkett 1986; Rosenstone et al 1986; Weng 2004). The use of five options allows two choices to be placed on either side of a ‘neutral’ mid-point and doesn’t overload the respondent with too many choices. Too many fine distinctions can be baffling and can confuse precision with accuracy (DeVaus 2014, p.107).

The five-point Likert Scale type questions adopted in both teacher and student questionnaires, had five levels of agreement where, 1=Strongly Agree, 2 = Agree, 3= Unsure, 4 = Disagree, 5= Strongly Disagree. Many of the scales designed for the teacher questionnaire match those used in the student questionnaire, such as, the ‘use of various teaching approaches’, ‘difficulty of science’, and ‘students’ self-concept in science’ scales. This was done intentionally so that the two questionnaires could be analysed in correlation with each other.

Furthermore, when dealing with the possible sensitive issues in the questionnaire, such as the possibility of various teaching approaches affecting students’ motivation in science, caution had to be taken to prevent obtaining socially desirable responses from the teacher participants. Social desirability, according to Holtgraves (2004) refers to “a tendency to respond in self-report items in a manner that makes the respondent look good rather than to respond in an accurate and truthful manner” (p.161). In an attempt to reduce respondents’ propensity to give
socially desirable answers, the normalcy of socially ‘undesirable’ behaviour was suggested in the questionnaire, as recommended by Lietz (2010)\textsuperscript{24}.

Compared to what was included in the student questionnaire, teacher respondents had a greater opportunity to respond to some of the questions in an open-ended format. This allowed the teacher respondents to comment on their least favourite teaching topic on the junior cycle science curriculum, and also to discuss what additional factors they think can affect students’ motivation in science. The open-ended question type was particularly useful here as all of the possible answers were either unknown to the researcher, or there were so many possible categories of response that if all responses were included in the closed questions, it would have made the questionnaire too long. These open-ended questions also enabled the respondents to answer as much as they wished, and were particularly apt as the complex issue of student motivation was being investigated, for which, often simple answers cannot be provided.

Before the questionnaire was administered it was piloted in March 2014 with 3 separate groups of people: a small group of chemistry education researchers from the University of Limerick, 3 in-service science teachers, and a group of 5 people with no formal background in science education. The questionnaire was piloted with all three groups, separately, in a focus group format. The group was asked to examine the questionnaire and to discuss the content, language, phrasing and layout of the questionnaire. The focus group format allowed the researcher to ask the group how they interpreted particular questions and to inquire about their suggestions of changes to make to the questionnaire.

The data from the pilot study was reviewed and subsequent changes made. The final questionnaire consisted of closed (dichotomous, ranking and rating scale) and open-ended questions, as mentioned already. Prior to conducting the study ethical approval was sought and attained from the Research Ethics Committee at the University of Limerick (ethical issues are discussed in greater detail under the relevant heading).

**Sample**

In this study, as in most other studies, limits on time and resources would have made it impossible to include all second-level schools. It was therefore necessary to select a smaller group of schools on which to target the student and teacher questionnaires. It was discovered

\textsuperscript{24} See Appendix 1 for teacher questionnaire.
that the number and type of second-level schools in Munster were mostly representative of the
total national cohort of post-primary schools in the 2012-2013 school year (see Table 3.1 and
3.2 below) and thus, the second-level schools in Munster acted as the sampling frame for the
research project.

*Table 3.1: Breakdown of post-primary schools in Ireland according to school type.*

<table>
<thead>
<tr>
<th>School Types in Ireland</th>
<th>Total Secondary</th>
<th>Total Vocational</th>
<th>Total Community and Comprehensive</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Schools</td>
<td>375</td>
<td>253</td>
<td>93</td>
<td>721</td>
</tr>
<tr>
<td>Percentage of Total School Types</td>
<td>52%</td>
<td>35%</td>
<td>13%</td>
<td>100%</td>
</tr>
</tbody>
</table>

(Source: Department of Education and Skills 2013)

*Table 3.2: Breakdown of post-primary schools in Munster according to school type.*

<table>
<thead>
<tr>
<th>School Types in Munster</th>
<th>Total Secondary</th>
<th>Total Vocational</th>
<th>Total Community and Comprehensive</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Schools</td>
<td>118</td>
<td>70</td>
<td>24</td>
<td>212</td>
</tr>
<tr>
<td>Percentage of Total School Types</td>
<td>56%</td>
<td>33%</td>
<td>11%</td>
<td>100%</td>
</tr>
</tbody>
</table>

It should be pointed out here first and foremost that there are three different types of post-
primary schools in Ireland. The main type, *secondary schools* (traditionally single-sex schools
but an increasing number are now co-educational), tend to be privately owned and managed.
They are under the trusteeship of religious communities, boards of governors and individuals.
*Vocational schools* are the second most predominant post-primary school type in Ireland.
They are mainly co-educational and are owned by local Education and Training Boards
(ETBs), formerly known as Vocational Education Committees (VECs). Finally, *community*
and comprehensive schools, which form the minority of schools, also tend to be co-educational and are managed by Board of Managements, which are representative of local interests. The second thing to note here is that approximately a third of secondary schools in Ireland (38% in Munster) are single-sex schools, a situation that is almost unique in Europe (Department of Education and Skills 2013, McGuire 2015, Smyth 2010).

Returning to the sampling approach employed in this study, the researcher decided to concentrate the distribution of questionnaires to 100 schools in the Munster area. In order to achieve an accurate and representative range of school types, a stratified sampling approach was employed. Stratified sampling is a modification of simple random sampling and is designed to produce more representative and thus more accurate samples (DeVaus 2014, p.71). It involves dividing the population into homogenous groups, each containing subjects with similar characteristics and then randomly sampling within these groups, the size of each group being determined by the judgement of the researcher (Cohen et al 2007). Stratification does not violate the principle of random selection because a probability sample is subsequently drawn within each stratum (Frankfort-Nachmias and Nachmias 1996). This method involved grouping the total number of post-primary schools in Munster, 212, into three different strata as outlined in Table 3.2. To account for the 56% of secondary schools in Munster, the 33% of vocational and 11% of community and comprehensive schools in the 100 school sample, 56 schools were picked at random from the total of 118 secondary schools in Munster, 33 were picked from the total number of vocational schools and 11 were chosen from the community and comprehensive list. Each of the 212 schools in Munster was then assigned a number, according to the type of school. The Random Number function in SPSS25 version 21 was used to generate a list of the random numbers, and hence, the list of random schools chosen for the sample.

Fieldwork
The 100 sample schools were contacted and informed about this research project by letter in April 2014. April was chosen as a good time of year to distribute the questionnaires, as both students and teachers would be able to complete the questionnaires based on their past year of study/teaching of science in school (and this would also enable first year students to participate in the study after completing almost a full year of science at second-level). However, it was equally as important to take into account that all of the schools needed to be

25 SPSS is a statistical software package that is widely used to analyse quantitative data.
contacted and informed about the study, they had to confirm their participation in the project, administer the consent forms and student questionnaires, and return all data before the end of the school year (June 2014).

In order to complete this process as quickly and efficiently as possible, the names of the science teachers in the 100 sample schools were firstly researched by telephoning the various schools inquiring about the names of their science teachers. In some cases where this proved unsuccessful, the teachers’ names were then researched using the school website and an additional website where students ‘rate’ their teachers online (http://ie.ratemyteachers.com/). The researcher felt that it was particularly important to address the written letters to specific science teachers informing them about the project, in order to maximise their potential involvement in the project. Three teacher questionnaires with consent forms and information sheets were also included with each letter to the 100 schools, as it was estimated that there would be approximately three science teachers per school. The science teacher was notified in the letter what their involvement in the project would entail, and potentially what their junior cycle science students’ involvement would comprise of. Once the letters had been posted to the specific science teachers within the 100 sample schools, an email and/or phone call to the school was used to remind teachers about the research project.

Profile of Respondents
This section provides a breakdown of the teacher participants involved in phase 1 of the study. In total 77 teachers responded to the teacher questionnaire from 48 schools. Although the response rate of 25.67% is not extraordinarily high, it should be pointed out that 48% of the total schools participated in the research. The majority of the teacher questionnaire respondents (65%) were female, which reflects the composition of the teaching profession (ASTI cited in McGuire 2015, Drudy et al. 2005).

Student Questionnaire
This questionnaire sought to gather data on pupils’ motivation in, and attitudes towards science. The decision to use a questionnaire as a data collection tool reflected the need to collect a considerable amount of data relatively easily and inexpensively, in a form that could be administered without the presence of a researcher, and that could be readily coded for analysis. In addition to this, the anonymous nature of the questionnaire and the relative ease of completion of the questionnaire were also taken into account. The limitations of such an approach were considered, as described section 3.3.
For ease of completion for the respondents, and for data comparison and analysis, highly structured, closed-questions were selected as the predominant types of questions to be included in the student questionnaire. Once again, these advantages had to be weighed up against the disadvantages. One of the major problems of closed-choice questions is that, on some issues, they can create false opinions either by giving an insufficient range of alternatives from which to choose or by prompting respondents with ‘acceptable’ answers (DeVaus 2014, p.99). Equally, the closed-choice approach is not very good at taking into account participants’ qualifiers to the answers they select (ibid). This must be looked at from two perspectives however. Closed questions do not discriminate against the less talkative and less articulate respondents. Asking people to formulate their own responses in open-ended questions is acceptable for those who can do it, but the danger is that “researchers will be overly influenced by these responses and ignore the opinions of the less articulate and less fluent” (ibid, p.99).

The types of closed questions that were used in this questionnaire were Likert scale questions. It was decided that these scales would be arranged in a grid format, as each scale would comprise of sets of items, to save space and to aid the respondents in completing the questionnaire as easily as possible.

The student questionnaire is 4 pages in length and is divided into 5 parts:

1. Students’ demographics
2. Students’ attitude toward science in school
3. Teaching approaches used in science class
4. Students’ motivational orientations: goal orientations, self-concept beliefs, control of learning beliefs.
5. Scientific career aspirations

This questionnaire was piloted with the same 3 groups of people as was done for the teacher questionnaire. After this initial pilot phase, the researcher was able to make changes to the questionnaire before piloting it again in a mixed second-level school, with 100 students, ranging from 1st-3rd year. The results obtained from these questionnaires were examined, coded, inputted into SPSS version 21, analysed and evaluated. Analysis of the data highlighted the areas in need of improvement in the questionnaire. The necessary modifications were then made (see Appendix 2 for the student questionnaire). Again, prior to conducting the study ethical approval was sought and obtained from the Research Ethics Committee at the University of Limerick (which will be discussed in greater detail below).
Sample
The random stratified sample, as described in the teacher questionnaire section, was also the sample for the student questionnaires. The letters that were posted to the various teachers in the 100 schools invited not only the teachers to participate in the study, but also the junior cycle science students in their school. Of these 100 schools, 11 schools (11%) agreed to take part in the study by involving both their junior cycle science students. However, only 10 of the initial 11 schools participated fully by returning the completed student questionnaires. Table 3.3 illustrates the type and gender of the schools that participated in the study.

Table 3.3: Overview of the participating schools by school type and school gender.

<table>
<thead>
<tr>
<th>School Type</th>
<th>Secondary</th>
<th>Vocational</th>
<th>Community &amp; Comprehensive</th>
<th>All-Girls</th>
<th>All-Boys</th>
<th>Mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Schools in Munster (212)</td>
<td>118 (56%)</td>
<td>70 (33%)</td>
<td>24 (11%)</td>
<td>46 (22%)</td>
<td>34 (16%)</td>
<td>132 (62%)</td>
</tr>
<tr>
<td>Selected Sample of Schools (N=100)</td>
<td>56 (56%)</td>
<td>33 (33%)</td>
<td>11 (11%)</td>
<td>21 (21%)</td>
<td>18 (18%)</td>
<td>61 (61%)</td>
</tr>
<tr>
<td>Schools from which Students Only Participated in Study (n=2)</td>
<td>2 (100%)</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Schools from which Students and Teachers Participated in Study (n=8)</td>
<td>2 (25%)</td>
<td>4 (50%)</td>
<td>2 (25%)</td>
<td>1 (12%)</td>
<td>0</td>
<td>7 (88%)</td>
</tr>
<tr>
<td>Schools from which Teachers-Only Participated in Study (n=40)</td>
<td>22 (55%)</td>
<td>16 (40%)</td>
<td>2 (5%)</td>
<td>9 (22.5%)</td>
<td>5 (12.5%)</td>
<td>26 (65%)</td>
</tr>
<tr>
<td>Total Participating Schools (n=50)</td>
<td>26 (52%)</td>
<td>20 (40%)</td>
<td>4 (8%)</td>
<td>10 (20%)</td>
<td>6 (12%)</td>
<td>34 (68%)</td>
</tr>
</tbody>
</table>

Fieldwork
A letter was sent to the principals in each of the 11 schools that agreed to administer the student questionnaires. Contact was also made with the cooperating teachers via email to
organise the administration of the student questionnaires. Once each school confirmed the number of student questionnaires that they would administer, the questionnaires were printed with the specific school code numbers\(^{26}\) and sent to the respective schools with the necessary consent forms and information sheets. Stamped, addressed envelopes were included in the package of questionnaires that were sent to each school. This was done in order to facilitate the efficient return of the completed questionnaires and consent forms. It was necessary to follow-up with all of the science teachers in the participating schools to remind them to return the completed questionnaires and consent forms. This was done via email. One school did not return the student questionnaires.

**Profile of Respondents**

In total, 1427 student questionnaires were returned out of a potential total of 2330\(^{27}\), yielding a response rate of 61.2%. There was quite an even spread of male (46.4%) and female (53.2%) respondents, as there was of student respondents in 1\(^{st}\), 2\(^{nd}\) and 3\(^{rd}\) year of their junior cycle science course, as can be seen in Table 3.4. Further details of the demographics of the respondents, both students and teachers, will be portrayed in the results chapter.

**Table 3.4: Profile of the student respondents.**

<table>
<thead>
<tr>
<th>Total No. of Student</th>
<th>Gender (6 Missing)</th>
<th>Year of Study (12 Missing)</th>
<th>School Type (5 Missing)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>1(^{st})</td>
</tr>
<tr>
<td>1427</td>
<td>662 (46.4%)</td>
<td>759 (53.2%)</td>
<td>482 (33.8%)</td>
</tr>
</tbody>
</table>

**Phase 2: Interviews and Focus Groups**

The author decided to conduct in-depth interviews and focus groups with a sample of the questionnaire respondents. The interviews were carried out with 3 science teachers in one school and they were semi-structured in nature, in that the interviewer had a set of questions

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\(^{26}\) Code numbers were used to protect the identity of the school, students and teachers. This will be discussed in more detail later.

\(^{27}\) 2330 student questionnaires were sent to the 11 interested schools. Of these, 1427 questionnaires were returned completed, from 10 of the schools. One school did not return the student questionnaires.
but was free to deviate at times if the interviewee ‘opened up an avenue of conversation not already catered for in the schedule’ (Ryan et al. 2006, p.152). The interview questions explored:

- Teachers’ perspectives of the **major influences** on students’ motivation in science in school.
- Teachers’ opinions about the role of the teacher on students’ motivation in science in school.
- Teachers’ views on the role of technology and how this can affect students’ motivation in science in school.
- Teachers’ insights into whether it is possible to reengage disengaged students in science.

Three focus groups were also conducted with groups of six 1st year students, six 2nd year students and six 3rd year students in the same co-educational school as the teacher interviews. The aims of carrying out the focus groups were to:

- Gain greater insight into students’ motivational orientations from the students’ perspectives.
- Reinforce the results obtained from the quantitative study.
- Identify factors of the classroom environment that influenced students’ motivation in science from the perspectives of **highly motivated** students, those appearing **low in motivation** and those who portray a **moderate level of motivation** when studying science in school.

The focus group was decided upon as the best method to use when researching the students’ perspectives, as focus groups are likely to encourage a variety of viewpoints on the topic in question (Creswell 2013). The role of the group moderator, i.e. the researcher, is to introduce the topics for discussion and to facilitate the interchange (Kvale and Brinkmann 2009). With this approach however, the researcher was aware that care needed to be taken to encourage all participants to talk and to monitor individuals who may dominate the conversation (Creswell 2013).

The interview and focus group questions were devised based on the main themes emerging from the questionnaire data (e.g. the major influence of the teacher on students’ motivation to learn science in school) and aspects previously not examined in the questionnaire (e.g. students’ attitudes towards technology and how it impacted on their learning of science in
school - one student quoting that “Donna don’t need science. I have Google!” in one of the student questionnaires).

**Sample**

The sample for the qualitative study was selected on analysis of the quantitative data. One school was chosen in which to carry out the interviews and focus groups, based on it being a large co-educational secondary school which drew students from a range of local areas in the vicinity of the school. It was found that the student questionnaires from this school produced a wide variety of responses which was of particular relevance to the researcher. This school also returned 7 teacher questionnaires which indicated to the researcher that the school employed a number of science teachers who appeared to be interested in partaking in science education research. On a further note, the cooperating teacher, who the researcher had been dealing with in regards to the quantitative part of the study, had been extremely helpful and cooperative. Hence, this school was selected in which to undertake phase 2 of the research study.

In determining the sample of students to be included in the focus groups, a *maximum variation sampling* approach was adopted. This approach consists of determining, in advance, some criteria that differentiate the sites or participants, and then selecting sites or participants that are quite different on the criteria (Creswell 2013). When a researcher maximises differences at the beginning of a study, it increases the likelihood that the findings will reflect differences or varied perspectives (*ibid*). As stated previously, the researcher was interested in finding out what factors, if any, differentiated highly motivated students from those moderate or low in motivation to study science at junior cycle level.

For reasons of time and resources, it was decided to interview three teachers for the teacher interviews, all of whom taught junior cycle science at the time of the study.

**Fieldwork**

Firstly, pilot interviews were conducted with 3 science teachers from 3 schools. The pilot cases were selected on the bases of access, convenience and geography proximity. The process of piloting enabled the researcher to refine the interview questions. A trialling stage was then also carried out with a further science teacher in order to:

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28 Donna is a pseudonym used here in order to protect the identity of the student.
• Give the researcher a “feel” for the interview process – a perception that it is not as simple as one might have expected.
• Alert the researcher to the range of factors that give an interview flavour and direction: the ‘management’ dimension.
• Focus the researcher on what it is about questions that makes them productive and stimulating – or the contrary.
• Highlight key questions and indicate those that are redundant, and those that need rethinking.

(Gillham 2000)

Modifications were made to the interview script before contact was made with the interviewees to organise the logistics of the interviews.

Secondly, the focus groups were piloted and trialled with a group of three 1st year science students and a further group of three 3rd year science students respectively, from 3 different schools. Again, the necessary changes were made to the focus group script before arranging to travel to the sample school to collect the qualitative data.

The cooperating teacher in the sample school that the researcher had been dealing with previously was contacted and invited to partake in the research study. The principal of the school was also informed about the project via a written letter and his approval was sought. On confirmation of the school’s willing involvement in the project, the cooperating teacher selected two other junior cycle science teachers to participate in the teacher interviews. Furthermore, the cooperating teacher selected six students from 1st year, six students from 2nd year and six students from 3rd year to partake in the focus groups, based on maximum variation sampling (i.e. each group of six students comprised of two highly motivated, 2 moderately motivated and 2 low in motivation science students). Information sheets and consent forms were then sent to the school for the participating teachers, participating students and for the relevant parents/guardians. A stamped addressed envelope was also included with the package of consent forms, again to ensure their prompt return.

A suitable time for conducting the interviews and the focus was arranged. The three teacher interviews and three focus groups were then conducted in the school and on the same day. Both interviews and focus groups lasted approximately one class period (35 minutes). The
interviews and focus groups were recording using a dictaphone with the permission of all participants.

Profile of Respondents
Table 3.5 portrays the profiles of teacher participants involved in phase 2 of the research study and Table 3.6 provides an overview of the student participants.

Table 3.5: Participant profile of the teacher interviews.

<table>
<thead>
<tr>
<th>Teacher Participants</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Subject Specialism</td>
</tr>
<tr>
<td>Female</td>
<td>Physics and biology</td>
</tr>
<tr>
<td>Female</td>
<td>Science and physical education</td>
</tr>
<tr>
<td>Female</td>
<td>Biology and physical education</td>
</tr>
</tbody>
</table>

All of the teacher participants were female, with varying degrees of teaching experience. The teachers’ subject specialisms also varied, with no teacher specialising in chemistry education.

Table 3.6: Student profiles involved in the focus groups.

<table>
<thead>
<tr>
<th>Student Participants</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation Level</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Year</td>
</tr>
<tr>
<td>High</td>
<td>Male &amp; female</td>
</tr>
<tr>
<td>Moderate</td>
<td>Male &amp; female</td>
</tr>
<tr>
<td>Low</td>
<td>2 females</td>
</tr>
</tbody>
</table>

The students involved in the focus groups included both males and females. Females represent both the most highly and least motivated students in the focus groups. Further analysis of the students that participated in the study will be reviewed in the results chapter.

3.5 Data Analysis
This section describes the analysis procedures involved in analysing the quantitative and qualitative data respectively. Data analysis of any kind, involves some form of transformation of data into “clear, understandable, insightful, [and] trustworthy” findings (Gibbs 2008, p.1). In relation to quantitative data, analysis tends to follow a number of set rules and procedures.
Qualitative data analysis, on the other hand, is somewhat more ambiguous and subjective, as will be described below.

**Quantitative Data Analysis**

Both the teacher and student questionnaires were analysed in the same format. They were firstly analysed separately, before they were then evaluated together in order to discern the main factors that influence students’ motivation in science. The qualitative and quantitative questions were analysed separately.

Once all of the questionnaires were returned, they were collated according to teacher and student questionnaires, and according to their school identification number. The questionnaires were then separately coded where each closed question and its possible variables were assigned specific numerical values. These numbers were then appropriately inputted into the latest version of IBM SPSS (version 21), creating two separate files for the data obtained from the teacher and student questionnaires respectively.

The responses to the open questions were transcribed verbatim, and analysed in a qualitative manner as will be described below.

The student questionnaires in particular, generated a massive amount of data and as a result, allowed for detailed analysis and discussion. The first step in analysing quantitative data is to examine it, to do exploratory analysis, looking at descriptive statistics, such as the frequencies of responses, gender proportions, age distributions, percentages of year of study etc (Saunders 2015). Then, tests for normality must be carried out to distinguish if the data is parametric or non-parametric, using the Kolmogorov-Smirnov test. Non-parametric data are those which make no assumptions about the population, while parametric data assumes knowledge of the characteristics of the population. In order for inferences to be made on parametric data, a normal bell-shaped curve of distribution is assumed.

All data obtained from the questionnaires in this study were non-parametric. After the preliminary results were produced, cross tabulations were used to investigate the influence of contributing factors. This analysis involved determining which variables had an effect on the respondents’ motivational orientations and answers given e.g. gender, year of study, school type etc. The appropriate tests, predominantly the Chi-squared test, were then used to investigate the statistical significance of the effect of these variables.
As the majority of the student questionnaire was composed of Likert scales, which were in turn made up of numerous items, it was necessary, in some instances, to use the mean values or scores generated per scale, as opposed to each individual item, to provide an overall picture of, for example, students’ attitudes towards science, their motivational orientations and their aspirations for a career in science. There has been ongoing debate since the 1930s regarding the use and analysis of Likert scale data (Stevens 1946; Parsons 2013). Jamieson (2004, p.1217-18) claims that the mean of the items in a Likert scale is “inappropriate for [such] ordinal data”. Contrary to this, Clason and Darmody (1994, p.34) conclude that “it is not a question of right and wrong ways to analyse data from Likert-type items” and they suggest that “statistical procedures that meaningfully answer the research questions, maintain the richness of the data.. should be the methods of choice in analysing Likert-type items”.

With regard to the data collected for this study, it is clear that the most appropriate method of analysing and describing the Likert scale data is to use the mean values of the contributing items. The slight skew in some of the respondents opinions on these scales is precisely why the mean is a more useful and interesting representation of central location (for example, the mean of 1.5 for performance goal orientations compared to 2.0 for mastery goal orientations) than the median which would invariable come out as ‘2’, thus losing any helpful differentiation between variables of interest.

**Qualitative Data Analysis**

The same set of structured procedures cannot be said to apply to qualitative data analysis, as few rules for analysing such forms of data exist (Bryman 2004). Qualitative data analysis involves making sense of data in terms of the participants’ definitions of the situation, noting themes, categories and regularities (Cohen et al. 2007). The first step in this analysis begins with data collection and transcription. After this, there are two essential strands:

- Identifying key, substantive points,
- Putting these points into categories.

(Gillham 2000)

Categories are simply headings *(ibid)*. The information from transcripts is ‘coded’ into these categories or themes. This approach is used to distil the large amounts of data into an organised body of concepts and ideas (Stringer 2014). It is important to remember that not all of the data is used in a qualitative study, some may be discarded (Wolcott 1994).

The steps that were taken in analysing the qualitative data in this study are outlined below.
**Step 1:** All of the data were collected and organised into open responses from student questionnaires, teacher questionnaires, teacher interviews and student focus groups respectively.

**Step 2:** The qualitative data obtained from the questionnaires and from the interviews and focus groups were transcribed into individual documents verbatim.

**Step 3:** The researcher then immersed herself in the data, reading through the transcripts, in an attempt to become fully aware of the world of the respondents (Burnard 1991), whilst also making notes of important points emerging from the data.

**Step 4:** Recurring themes emerging from the data were then recorded. This step is also referred to as coding. Each theme was divided into separate word documents. Whilst doing this the researcher was conscious that some of the qualitative data may be relevant to more than one theme.

**Step 5:** Sub-themes or sub-categories were then devised, reflecting participants’ different view points on the same overarching theme. This step was continued until data saturation occurred, where no additional data was emerging in relation to each theme and no new themes were emerging from the data (Strauss and Corbin 1998).

**Step 6:** The final stage in the analysis of the qualitative data involves interpretation. Put simply, interpretation refers to making sense of the data (Creswell 2013), considering the themes in relation to the quantitative data, where relevant, and also to existing literature.

It should be acknowledged that “the choosing and identifying of categories [or themes] is a subjective business” (Gillham 2000, p. 59). Hence, throughout the qualitative data analysis in this research project, a critical friend was used to ensure the data in each theme and sub-theme was accurate and that the author was consistent in her approach. This added to the validity of this research method which will be described in greater detail below.

### 3.6 Validity and Reliability

“It is unwise to think that threats to validity and reliability can ever be erased completely; rather, the effects of these can be attenuated by attention to validity and reliability throughout a piece of research”.

(Cohen *et al* 2005, p.107)
For this reason, certain measures were put in place to maximise the reliability and validity of the instruments used in this study. It is important, first of all, to understand what is meant by these terms. They will be discussed in greater depth under the relevant headings.

**Validity**

Validity may be defined as “the degree to which a survey instrument assesses what it purports to measure” (Fink 1995, p.49). The validity of a measure then depends on how the concept it is to measure, has been defined (DeVaus 2014). There are three basic ways in which to assess validity: **criterion validity**, **content validity** and **construct validity**. Criterion validity compares how people answer on a new measure of a concept, with existing, well-accepted measures of the concept. There are problems with this, however. Firstly, the validity of the established measure is assumed, and secondly, for many concepts in the social sciences there are no well-established measures against which to check the new-measure (ibid). Content validity refers to the extent to which the indicators measure the different aspects of the concept. The question that must be asked here is, “has every aspect of the concept been taken into account?” (ibid, p.51). Finally, construct validity uses theory to validate the instrument or measure. How well the measure conforms to theoretical expectations is the basis for this assessment. The researcher needs to be conscious of avoiding developing a test so that it supports the theory, and to avert from using theory that is not well supported (ibid).

In the current study, efforts to enhance the validity of the instruments used were undertaken by:

- Carefully selecting random stratified samples for phase 1, the quantitative phase.
- Ensuring large sample sizes in the quantitative study (n=1427 students, n=77 teachers).
- Including stamped addressed envelopes for all documentation that needed to be sent back to the researcher.
- Checking the names of the science teachers to which the invitation to partake in the research study was sent.
- Following up questionnaires with a phone call/email.
- Rigorous piloting of instruments.
- Obtaining feedback from a critical friend through all phases of the research design.

At each phase of the project the researcher tried to increase the sample sizes so as to improve the extent to which the research findings could be generalised. For example, in phase 1...
teacher questionnaires were resent to the schools that had initially not completed any questionnaires, along with a gentle reminder to the teacher about the aims of the project and the significance of the research. This proved successful, increasing the teacher response rate from 16.7% to 25.67%.

A further approach used by the researcher to improve the validity of the research was in the triangulation of the data, by comparing the interview and focus group data with that from the questionnaires.

A final point on the validity of the current study, and referring back to an item listed above, is that the interview questions and both the closed- and open-ended questions in the questionnaires were enhanced through the use of a critical friend. This critical friend “served as an intellectual watchdog” (Rossman and Rallis 2003, p.69) helping to “strengthen the value of what [was] concluded” (ibid, p.66).

**Reliability**

Reliability, on the other hand, refers to “dependability, consistency, and replicability over time, over instruments and over groups of respondents” (Cohen et al 2007, p.146). In short, it focuses on the stability of results across time, settings and samples (Stringer 2014). There are a number of well-established methods of testing the reliability of indicators. The most popular methods, such as the calculation of Cronbach’s alpha, only apply to measuring the reliability of scales where there is a set of questions to measure the one concept rather than single-term indicators (DeVaus 2014). Cronbach’s alpha is a measure of how consistent a person’s response on an item is compared to each other scale item (ibid). This provides a measure of the overall reliability of the scale. The index of this test, is given by a statistic, Cronbach’s alpha coefficient, which ranges between 0 and 1. The higher the coefficient, the more reliable the scale. It should be reiterated that “the best way to create reliable indicators is to use multiple-item indicators” (ibid, p.50). Hence, this style of question was adopted in the both the student and teacher questionnaires that were developed for this study.

Table 3.7 provides an overview of the reliability of the scales used in the student questionnaire, which was composed almost entirely of such scales. According to DeVellis (2003), a coefficient above 0.80 is very good, 0.70 -0.80 is respectable, 0.6-0.69 is undesirable to minimally acceptable, and below 0.60 is unacceptable.
Table 3.7: Cronbach’s alpha coefficients for the scales used in the student questionnaire.

<table>
<thead>
<tr>
<th>Part of Questionnaire</th>
<th>Scales</th>
<th>α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes towards science</td>
<td>Interestingness of science (5 items)</td>
<td>0.875</td>
</tr>
<tr>
<td></td>
<td>Relevance of science (3 items)</td>
<td>0.659</td>
</tr>
<tr>
<td></td>
<td>Difficulty of science (3 items)</td>
<td>0.817</td>
</tr>
<tr>
<td>Teaching approaches used in science class</td>
<td>Context-based approach (4 items)</td>
<td>0.649</td>
</tr>
<tr>
<td></td>
<td>Inquiry-based approach (4 items)</td>
<td>0.582</td>
</tr>
<tr>
<td></td>
<td>Didactic approach (3 items)</td>
<td>0.546</td>
</tr>
<tr>
<td>Motivational orientations in science class</td>
<td>Mastery goal orientation (3 items)</td>
<td>0.740</td>
</tr>
<tr>
<td></td>
<td>Performance goal orientation (2 items)</td>
<td>0.622</td>
</tr>
<tr>
<td></td>
<td>Science self-concept (3 items)</td>
<td>0.703</td>
</tr>
<tr>
<td></td>
<td>Control of learning beliefs (3 items)</td>
<td>0.724</td>
</tr>
<tr>
<td>Career aspirations in science</td>
<td>Interest in pursuing a career in science (7 items)</td>
<td>0.849</td>
</tr>
</tbody>
</table>

The coefficients here range from 0.546 to 0.875. Most of the scales employed in the questionnaire are classified as reliable, with two scales regarded as unacceptable. The findings from these particular scales need to be interpreted with caution, however, it should also be pointed out that the average overall Cronbach’s alpha for the instrument is 0.706, which is considered reliable according to DeVellis (2003).

In relation to the design of the questionnaire, it was necessary to create a new instrument, as no existing motivational questionnaires were suitable for this study. Care was taken by the researcher to consider the limitations in doing so, as outlined in the literature review. Moreover, the researcher considers a “standardised” motivational instrument to be impossible as motivation is such a contextual and content-specific construct as discussed in detail previously. Hence, the need for triangulation of methods in this motivational research study, as in others.

With regard to the reliability of the teacher questionnaire, scales were also used in this measurement tool, although not to the same extent as in the student questionnaire. The Cronbach’s alpha coefficients for the students’ self-concept scale, the demanding nature of the science subject scale and the relevance of school science to students’ everyday lives scale are 0.712, 0.594 and 0.504 respectively. The average Cronbach’s alpha for the scales used on the teacher questionnaire is 0.60, which is regarded as acceptable. These scales were used to determine whether or not teachers’ perceived them to be influential factors on students’ motivation to study science in school.
3.7 Ethical Considerations

Research design must include ethical considerations to protect the well-being and interests of research participants (Stringer 2014). Before conducting this research, ethical approval was sought from the University of Limerick Research Ethics Committee (ULREC). As participants in the project involved students under the age of 18, the University of Limerick’s Child Protection Form was signed and submitted with the ethics application\(^{29}\).

For research carried out in schools it is vital that informed consent be given by the school principal, the teacher(s) involved, the parent/guardian of the participant and the participant themselves. For this reason, the necessary information and documentation, such as the consent forms (principal, parental/guardian, student and teacher) and information sheets, were then provided to the randomly selected schools that were willing to participate in the project. All of the information sheets and consent forms sent to the schools were headed with the official University of Limerick logo and also included contact details of the primary investigator, the researcher and the Chairperson of the Science & Engineering Research Ethics Committee.

Under the guidelines of the University of Limerick Research Ethics Committee, all information sheets included:

1. A brief description of topic and method – interview/group discussion etc. The description briefly explained what a participant would be expected to do.

2. Amount of time involved for participant.

3. Where the research would take place.

4. Any risks or benefits to participant.

5. Explanation of participant’s right to anonymity.

6. Rights of participant not to answer questions and withdraw at any time. Also right to contact Chair of the Science & Engineering Research Ethics Committee if they have any concerns about participating in the research.

7. Contact information: name of researcher/supervisor and Chair of Science & Engineering Research Ethics Committee. Included e-mail addresses for researcher and

\(^{29}\) See Appendix 3 for ethical documentation and approval for this project.
supervisor and phone number for Chair of Science & Engineering Research Ethics Committee.  

(ULREG 2014)

The principle of informed consent arises from the respondent’s right to freedom and self-determination (Cohen et al. 2007). With this in mind, the obligation to treat individuals “as autonomous agents” and to respect their decisions on whether or not to participate in research (National Research Council 2003, p.81), was given particular attention in the consent forms. It was highlighted, explicitly, that the individual’s participation in the project was voluntary and that he/she was free to withdraw from the project at any time. Once willing to partake in the research, participants signed a declaration on the consent form stating that they understood the nature of their participation in the research and their entitlements to full confidentiality in terms of their participation and personal details.

Throughout the research study, therefore, efforts were made to ensure the anonymity of the participants and the participating institutions. Each participating school was informed that data received from the student and teacher questionnaires would be used by reporting only combined results. Furthermore, each school was coded with a specific identification number. This number was then printed on both the student and teacher questionnaires that were administered to that particular school so that the identity of the second-level students and the teachers would not be known to the researcher. They would only be identifiable through their school identification number.

3.8 Limitations of the Study

All research, no matter how thorough, has limitations. The main limitations associated with this study are considered below.

First and foremost, in relation to phase 1 of the study, the researcher is aware that particular scales on both the student and teacher questionnaires may be problematic, and hence the results yielded from these scales must be interpreted with caution. As outlined previously however, the overall Cronbach’s alpha coefficients for both questionnaires proved reliable.

Secondly, as a consequence of the relatively low response rate to the teacher questionnaire the results obtained may not be entirely representative of the total cohort of science teachers in Ireland.
Thirdly, it is noted that the students who did participate in this study, despite the large number of them, may not be representative of the national cohort of junior cycle science students. The students who had the opportunity to respond to the questionnaire, it could be argued, have enthusiastic teachers who agreed to participate in the study by involving their students. This suggests a possible bias of student respondents, those who have a willing and committed teacher to research in the field of science education.

Fourthly, for feasibility purposes only three teachers were interviewed in phase 2 of the study. These three teachers were all female, and did not have different areas of expertise (i.e. there was no teacher that specialised in chemistry education). Furthermore, all three of the teacher participants were teaching in the same school, a large coeducational secondary school. The researcher understands that teachers from a single-sex school for instance, or those from a different school type with different school values, may result in different findings from the same interview questions. However, the researcher is also aware that the aim of this type of qualitative research is not to generalise. Rather, it is to gain insight and understanding of individual perspectives.

Finally, it should be acknowledged that some students involved in the focus groups in phase 2 of the research were more talkative or dominant than others. In fact, it was also observed that certain year groups were more open and willing to talk than others. Despite employing interview techniques to combat this, (e.g. easing the participants into the more difficult questions, and creating a comfortable, friendly and informal atmosphere), it still resulted in various groups being more or less forthcoming than others in discussing their opinions. This will be referred to again in the results chapter.

3.9 Conclusion

The methods used during this project have now been outlined. The phases involved in carrying out this project have been defined and the rational for the various methods used in each phase have been summarised. The validity and reliability issues have been explored and the limitations affecting the project have been identified. It is now possible to outline the results obtained from the quantitative and qualitative phases of the research in the next chapter.

3rd year students were the least open and talkative group out of the three groups. This, they stated, was normal in all of their classes and are usually acknowledged as the “quiet group” in the school.
Chapter 4: Results Chapter

4.1 Introduction
The current chapter is divided into three main sections, reflective of the research questions identified in chapter 3. All data presented within the three sections incorporates data from phase one (student and teacher questionnaires) and phase two (teacher interviews and student focus groups). The purpose of this is to triangulate the findings where relevant, providing as clear and holistic an insight as possible into the various aspects of students’ motivation that are under review. An overview of all of the main findings will be provided at the end of the chapter.

The first section outlines students’ orientations and levels of motivation to study junior cycle science in school. The data from this section will be presented under the following headings.

- Interest in School Science
- Perceptions of Science
- Career Aspirations
- Motivational Orientations

The second part of this chapter will focus on any perceived differences in students’ motivation as they progress through schooling. This data will be presented under the following two main headings:

- Transition from Primary School
- Progression in Post-Primary School.

The third and final section will explore the factors that emerge from the data as being influential on students’ motivation in science in school. The headings that will be used in this section will reflect those employed in chapter 2 (when a review of this topic in the literature was carried out) which are:

- Goals
- Learning Environment
- Science Self-Concept
- Other Factors.

What should be noted is that when direct quotes are used the following information is provided on participants from each phase:
• Phase one respondents are identified as student questionnaire respondent (SQR) or teacher questionnaire respondent (TQR). Phase two respondents are identified as interviewees or focus group participants.
• The gender of the respondent is outlined.
• The level of motivation for phase two focus group participants is stated.
• The year of study of the student participants will be indicated and for the teacher questionnaire respondents, the number of years teaching experience that they have will be stated. 31

4.2 Are Students Motivated to Study Science in School?
To answer this question, quantitative results from the student and teacher questionnaires will be drawn upon, followed by open-ended explanations given by both the students and teachers that were involved in the study. To recap, 1427 students completed the student questionnaires from 10 different schools throughout Munster (which are largely representative of the national cohort of schools in Ireland). 77 teachers returned the teacher questionnaires from 48 various Munster schools. One large co-educational secondary school participated in phase two of the research project involving 18 students (6 from 1st year, 6 from 2nd year and 6 from 3rd year) in focus groups. Three teachers also took part by agreeing to participate in individual interviews.

Interest in School Science
A summary of the students’ questionnaire responses to the Likert scale items relating to how interesting they perceive science in school to be is portrayed in Figure 4.1. It appears that, in the main, students do find science at school interesting but, do not necessarily look forward to science class or want to study as much science as possible in school. The mean value of students’ ratings of their overall interest in school science is 2.23 (where a figure of 1 indicates strong disagreement with the statement and 5 reflects strong agreement).

31 An example of a description for a phase one teacher respondent is ‘TQR: female, 12 years experience).
Figure 4.1: Student respondents’ level of agreement with statements relating to how interesting they find science in school (N = 1427).

In terms of the open responses associated with these statements, rather mixed reviews are reported about science as a school subject. It appears that students generally have an extreme view on it, either ‘loving’ it or ‘hating’ it. For instance, one student stated that “These questions were easy and I love doing science, it is very interesting!!!” (SQR: female, 3rd year). Furthermore, many of the students who reported enjoying science stated that they have done so “ever since [they] [were] a child” (SQR: female, 3rd year).

Other students stated that although they find science quite interesting, they don’t particularly enjoy ‘school science’, or rather, the way that science is taught in school. Students’ responses include:

“It’s not the subject that’s boring, it’s the way we have to learn it” (SQR: female, 2nd year)

“I don’t like science in school but I love science in general” (SQR: male, 2nd year)

“Although I really like science and find it interesting, I find the course boring sometimes and don’t look forward to class” (SQR: female, 2nd year).
The above comments relate to those from students who report not being interested in science. Many of the reasons given as to why they don’t like science refer to the ‘teacher’ and their methods of ‘teaching’:

“Irish students see science as a very boring subject. I think it should be taught in a more interesting way. I don’t like science at all” (SQR: female, 3rd year).

“Science was good until we got a new teacher. He can’t teach at all” (SQR: male, 2nd year).

“Students’ dislike towards science is down to their teacher, their own mindsets and their peers. I love science and enjoyed this questionnaire but most people in my class are the opposite as they do not link it to everyday life and the teacher isn’t the best at keeping control” (SQR: male, 2nd year).

On a final point here, results from the Chi-squared test on one particular item based on the ‘interest in school science’ scale reveals that there is a significant difference between students’ agreement of the statement ‘Science classes bore me’ and gender (p=0.05). Female students tend to agree with this statement more than males. No significant differences were found for the other interest items and gender.

**Perceptions of Science**

As outlined above, students appear to make a distinction between science and science in school. According to the results of the questionnaire, science in society is viewed as an important issue by students. 83.5% of the students surveyed agree\(^{32}\) that ‘science is important for helping us to understand the world’ (see Figure 4.2). Many students reinforced this opinion in the open responses to their questionnaire and in the focus groups. One student explained that “[they] find science rather boring but the fact that [they] might need it later on in life is mostly what [they] think about” (SQR: female, 1st year). Another student justified why they feel they need to study science in school, despite not particularly liking it: “Well like it’s hard….but you kind of need it a lot…for jobs and stuff” (focus group participant: female, high motivation, 1st year). On the other hand, one student felt that it was such an “important part of life” that “everybody should do it without choice for the Leaving Certificate” (SQR: male, 3rd year).

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\(^{32}\) As 5-point Likert scales were used in both questionnaires, for the purpose of clarity, responses for ‘strongly agree’ and ‘agree’ are grouped as ‘agree’ unless stated otherwise. Similarly, ‘strongly disagree’ and ‘disagree’ and grouped as ‘disagree’.
The perception of science in school as a difficult subject was ubiquitous in the data. Very few students reported that they found the subject easy in their open responses. One student however, found that “science is easy for [them]. [They] understand all the topics really easily but it is really boring so [they] don’t pay attention but [they] rarely get below 98%” (SQR: male, 1st year).

More common open responses relating to students’ perceptions of science include:

“I find science really complicated and really hard to remember for tests and study for tests” (SQR: female, 1st year).

“Some topics on the course are extremely difficult and hard to understand, especially physics and sometimes chemistry” (SQR: male, 3rd year).


“I think it’s a very hard subject” (SQR: male, 1st year).

“Science is hard in secondary school because there is too much to learn compared to other subjects” (SQR: male, 3rd year).

Figure 4.2: Respondents’ level of agreement with the statement ‘science is important for helping us to understand the world’ and ‘science is a difficult subject’ (N =1427).

Table: Respondents’ level of agreement with the statement ‘science is important for helping us to understand the world’ and ‘science is a difficult subject’ (N =1427).
“[To be a] Scientist seems fun but too hard and too much dedication needed” (SQR: male, 2\textsuperscript{nd} year).

“I think the science is very hard. I don’t like going to science at all but I have [to]” (SQR: female, 2\textsuperscript{nd} year.)

“I find science extremely hard and I really would drop the subject if I was allowed but I have to do it and I hate science, I’m not any good at the subject at all. Thanks” (SQR: male, 2\textsuperscript{nd} year).

What does emerge from many of these responses is that the physical science aspects of the junior cycle science course are viewed as particularly difficult, especially physics. A student, who is considered highly motivated in science class, explained that “[she] hates physics. It’s really hard. Because [she is] not very good at maths either then so it’s quite hard to do like” (focus group participant: female, highly motivated, 2\textsuperscript{nd} year). It was observed and noted that the students who were classified as ‘low in motivation’ toward science in school in the focus groups, irrelevant of year group, all agreed that that they don’t like physics because it’s ‘hard’.

Interestingly, there were no significant differences between those who found science in school difficult and gender. A significant difference did emerge from the data however, for year group (p=0.005), where 1\textsuperscript{st} year students perceive it be most difficult, followed by 3\textsuperscript{rd} years. 2\textsuperscript{nd} year students were the group that least agreed with the statement ‘science is a difficult subject’.

The reason why teachers think that students perceive same to be a difficult subject is due to a number of reasons, namely, the scientific language, it’s a time consuming subject, and the investigations\textsuperscript{34} that students must complete in 3\textsuperscript{rd} year are beyond students’ capabilities.

In terms of students’ scientific literacy, one teacher stated that “the language barrier for some students is a very big problem as [they have] extremely poor literacy skills” (TQR: female, 7 years experience). Another teacher mentioned that it is the “difficulty of school texts” (TQR: male, 30 years experience) that cause a problem for students in their study of science.

\textsuperscript{34} These investigations are intended to be inquiry-based in nature and form part of students’ practical assessment for their Junior Certificate science examination. Students are required to carry out two experiments, based on titles provided by the State Examinations Commission, write a report on them and submit them for grading.
A different perspective that some of the teachers had related to “the amount of time students need to spend studying science compared to a lot of other subjects” and claimed that this is what is considered “a major turn off for students”, concluding that science “is perceived as being interesting but difficult” (TQR: female, 20 years experience).

Moreover, comments relating to the Junior Certificate investigations cropped up in numerous teacher open-ended responses in their explanations as to why students find junior cycle science a difficult subject. Such comments include:

“Re the science investigations the majority of students that I teach are unable to do these without constant teacher input. These investigations are designed for only the more able students to whom they present a challenge and get a great sense of achievement from them. For the wide majority of my students they find the write up v. difficult due to poor communication skills” (TQR: female 33 years).

“[Students] are certainly incapable of completing Coursework B independently” (TQR: male, 18 years).

Career Aspirations
Despite students’ general belief that science is a difficult subject, the majority of those surveyed (58.4%) would like to study a science subject for their Leaving Certificate, with just less than ¼ (22.0%) stating that they would not like to further their studies of science for the Leaving Certificate.

Again, despite this relatively high proportion of students who wish to further their studies of science, very few students would actually like ‘to become a scientist’ or ‘would like to work with people who make discoveries in science’. To a greater extent students do think that science ‘has opened their eyes to new and exciting jobs’ (see Figure 4.3).

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35 Coursework B is commonly used to refer to the Junior Certificate science investigations.
There is a significant difference between gender and those that ‘would like to become a scientist’ (p=0.001) and those for which ‘science has opened [their] eyes to new and exciting jobs’ (p=0.004). Female students tend to disagree with the statement that they ‘would like to become a scientist’ moreso than their males counterparts. However, more females report that ‘science has opened their eyes to new and exciting jobs’ in comparison to male students.

Furthermore, many students’ comments in the open-ended questions on the questionnaire refer to the reason why they don’t have any aspirations to further their studies in science; they don’t perceive it to be relevant to their everyday lives or relevant to what they’d like to work at in the future. Many responses were similar to the following: “I don’t think we should have to study science all the way up to Junior Cert, because I don’t like it and I know I don’t want a job with anything to do with science but I still have to learn it when I could be studying something else” (SQR: female, unknown year).

Some students pointed out that it is specific science subjects that they are or are not interested in and hence, would either like to or not like to choose to study them for their Leaving Certificate or to pursue a career in them. For example:

“I prefer biology to physics and chemistry because it’s really interesting and biology is involved in the work I want to do in the future” (SQR: female, 3rd year).
“Science is a good subject to become a mechanic, so I’m going to try study science harder” (SQR: male, 2nd year).

Many teachers reinforced the point that students have preferred science subjects, where physics and chemistry are subjects that are not as attractive to students as biology:

“Biology is popular due to courses (3rd level) linked with it and also because it is seen as requiring you to just learn off material. Physics and chemistry are not as popular as they are perceived as more difficult, you cannot rote learn them or they require greater conceptual understanding” (TQR: male, 20 years experience).

The liking of the specific subject areas in the combined junior cycle science course will be explored in more detail under the heading ‘Task Value’ in section 4.4 of this chapter.

**Motivational Orientations**

As explored in detail in the literature review, students’ motivation not only varies in level, it also varies in type of motivation. According to the quantitative data collected for this study, the majority of students are motivated by a performance goal orientation, perhaps reflecting the focus of these goals in their family life, school life or even in society. Figure 4.4 illustrates the mean values obtained for students’ opinions about their levels of adoption of goal orientations (performance and mastery), their science self-concept and their beliefs of the control they have over their learning.

![Figure 4.4: Mean values of overall motivation orientation scales (N = 1427).](image-url)
Goals
The performance goal orientation resulted in the highest level of students’ agreement with statements such as ‘my main goal in science class is to get a good grade’. What is interesting to note about this is that students’ level of agreement with this statement did not significantly change with year group (p=0.145) or with gender (p=0.133). Thus, first year students are just as likely to be focused on getting a good grade as third year students.

Students’ responses to the open-ended questions reveal the importance they place on their teacher’s commitment to preparing them for tests. The following responses, from third and first year students’ respectively, indicate this clearly:

“We should be given exam papers in 1st year and told this is what we are doing in 3 years time, so that it’s not a shock to us in 3rd year” (SQR: female, 3rd year).

“I think our teachers should be more organised, laying out our hardbacks and experiment books. Also, I think they should have small tests during the course of the year for revision” (SQR: female, 1st year).

What also emerged in the students’ open responses was that students appear to be concerned, not only about the teacher’s preparation in ensuring that students are “ready” for tests, but also about comparing the outcomes of these tests among themselves. One student reported how she feels when this happens in class:

“I don’t like [it] when people get their test back [and] they show me their answer. I get upset then” (SQR: female, 1st year).

A teacher involved in phase two of this study referred to this in her interview. She outlined her thoughts on how the education system’s focus on assessment negatively affects pupils, particularly those lower in ability and/or motivation. She stated that “when you think about students coming up from primary school, they come into first year, they’re full of wonderment, they’re full of excitement, brimming with enthusiasm...and literally by the time they’ve sat their first test, they know where they stand in the pecking order in the classroom” (interviewee: A). She further described how the norm for teaching science in school is to “finish the chapter and boom (claps hands together) here’s the test”. The consequence of this, she explains, is that “the good children will do well and poor children or the weaker children won’t be able to cope. They’ll see that the difference in the grades, although you try
not to make it obvious, they know, you know, they know, and eventually comes the point then....[that students feel] ‘agghhh what’s the point’” (interviewee: A).

From a completely different perspective, a minority of students, according to students’ open-ended comments, really value and enjoy learning science for its own sake, adopting a mastery goal orientation. One student explicitly pointed out that she wants to “do well in science tests” for herself because she likes the subject “not because [she] wants others to think [she is] good at science” (SQR: female, 1st year). A final, interesting point to make on this is that students’ feelings that they “really like learning new things in science class” differed significantly\(^{36}\) for the year group (p=0.004); the older the year group, the less they agreed that they “really like learning new things in science class”.

Self-Concept
Students’ beliefs in their science ability proved rather low, with an overall mean value of 2.1 on the science self-concept scale, where 5 was the highest obtainable value. One particular comment that stood out from the student questionnaires as being exemplary of the types of responses students provided describing their feelings of their science self-concept is as follows:

“I find science extremely hard and I really would drop the subject if I was allowed but I have to do it and I hate science, I’m not any good at the subject at all…..I’d like to ‘do well in science class because it is important to show my family, friends and teacher that I am able to do well’” (SQR: male, 2nd year).

Unlike the rather mixed comments relating to how interesting students perceived science in school to be, the clear majority of comments relating to self-concept focused on students’ low sense of self-concept. Comments that were in the minority included:

“Science is easy for me. I understand all the topics really easily but it is really boring so I don’t pay attention but I rarely get below 98%”(SQR: male, 1st year)

“I don’t find science hard and I don’t need to do much studying for it” (SQR: female, 2nd year).

What should be pointed out here was that a number of significant differences were found relating to students’ science self-concept and gender.

\(^{36}\) A table of significant findings can be found in Appendix 4.
Table 4.1: Significant differences between science self-concept and gender ($N_{males} = 662$, $N_{females} = 759$, 6 respondents of unknown gender).

<table>
<thead>
<tr>
<th>Science Self-Concept Likert Item</th>
<th>P Value</th>
<th>Most in agreement:</th>
</tr>
</thead>
<tbody>
<tr>
<td>I find that science has lots of ideas that I can understand.</td>
<td>&lt;0.001</td>
<td>Males</td>
</tr>
<tr>
<td>I can easily understand new ideas in science.</td>
<td>&lt;0.001</td>
<td>Females</td>
</tr>
<tr>
<td>I am not as good at science as most of the other students in my class.</td>
<td>&lt;0.001</td>
<td>Females</td>
</tr>
</tbody>
</table>

Males tended to agree with the statement ‘I find that science has lots of ideas that I can understand’ more than females. Similarly, males expressed higher levels of science self-concept when they were more likely to disagree with the statement ‘I am not as good at science as most of the other students in my class’ than their female counterparts. On the other hand, one self-concept was in favour of females’ sense of higher self-concept, as they were more likely to agree that they ‘can easily understand new ideas in science’.

Control of Learning Beliefs

With regard to students’ perspectives on their ability to control their learning with learning strategies such as expending effort, it was found that females tended to believe that they could control their ability to learn more than males. Figure 4.5 below indicates students’ levels of agreement with one of the control of learning belief Likert items.

![Figure 4.5: Percentage of responses (by gender) in agreement with the statement ‘If I work hard enough I will be able to understand all of the science topics on the course’](image)

Figure 4.5: Percentage of responses (by gender) in agreement with the statement ‘If I work hard enough I will be able to understand all of the science topics on the course’.
Additional comments from the student questionnaire reveal mixed students’ perceptions on what it takes to learn science, that is, if it is due to innate ability or hard work. For example:

“You don’t need to study to get a good grade!” (SQR: male, 3rd year).

“I don’t like science because I find it hard even if I study everyday!” (SQR: female, 1st year).

“Science is not hard if you study it” (SQR: male, 2nd year).

“Studying hard still might not make you good at the subject, some people just naturally understand it” (SQR: female, 2nd year).

“No matter how much study I do, I can never understand most of science” (SQR: male, 3rd year).

The following section of this chapter will explore any trends emerging from the data in relation to students’ motivation and whether or not it changes as students progress through the junior cycle.

4.3 In What Way do Junior Cycle Science Students’ Motivational Orientations Differ in the First Three Years of Post-Primary Education in Ireland?

This section will be presented in two parts. The first part will deal with any data relating students’ transition into post-primary school from primary school. The second part will focus on students’ progression through the junior cycle in post-primary school.

4.3.1 Transition from Primary School

Much of the data that will be explored in this section will come from the transcripts of the students’ focus groups and teacher interviews. This transition period in students’ education was not explicitly referred to in either of the questionnaires in phase one of the research study.

A number of key themes became apparent about students’ transition from primary school into second-level education. The relevant data will be presented under the following three headings, reflecting the emerging themes:

1. Level of Treatment of Science in Primary School
2. False Expectations of Science in Post-Primary School
3. Increased Focus on Performance Goals in Post-Primary School.

**Level of Treatment of Science in Primary School**

The first thing to emerge from examining the transcripts from the students’ focus groups was that science is not ‘done’ or studied to a great extent in primary school, despite its introduction in the primary school curriculum in 2003. Many students reported that they “didn’t do a lot of science in primary school, like it wouldn’t be one of the subjects that [they did] a lot” (focus group participant: male, moderate motivation, 1st year). Or when it was done, it was exclusive to senior classes in primary school: “Well I remember that we…that we was in 5th and 6th class that we mostly did science” (focus group participant: female, low motivation, 1st year).

If students did get the opportunity to do science in primary school they commented on how it involved solely doing experiments and they “didn’t really learn much about them [the experiments]” (focus group participant: female, high motivation, 1st year). Although it was considered as fun by the students, for the most part it was also considered as “kind of hard to understand” (focus group participant: male, high motivation, 1st year).

Further examples of students’ reports on the lack of treatment or depth of study of science in primary school are as follows:

“No, no, we didn’t do any science at all in national [primary] school” (focus group participant: male, moderate motivation, 2nd year).

“It’s like we did kind of like SESE, you know, just kind of a mixture of like geography, science, history kind of together in the one thing” (focus group participant: female, high motivation, 2nd year).

“I don’t think we even did it, science” (focus group participants: group, 3rd year).

“Am we just did a lot of experiments…[secondary school is] very different to primary school. You do more like stuff about science rather than experiments” (focus group participant: female, high motivation, 1st year).

“We did do a lot of experiments…we didn’t really do much science [theory]” (focus group participant: female, high motivation, 2nd year).
“You do more stuff about science [in secondary school] rather than experiments”
(focus group participant: female, high motivation, 1st year).

“You kind of do way more learning...you kind of do the same [experiments], but you do more learning about them” (focus group participant: female, moderate motivation, 1st year).

False Expectations of Science in Post-Primary School
Both students and teachers referred to a sense of having false expectations of what the study of science would involve in post-primary school, mainly attributed to extravagant shows put on for Open Days37.

“Well like when we came in for the Open Day they were all doing these cool experiments....and I thought it was going to be like mostly experiments but when you go in [to secondary school] it’s only once a week, you just do one experiment like”
(focus group participant: female, high motivation, 1st year).

“I, well, I remember when I was coming in [to secondary school] at the very start in first year for the Open Day and you see all the experiments, doing them, and what we did at the start in first year was really fun and stuff but now.....I’m not that pushed towards doing experiments” (focus group participant: female, high motivation, 2nd year).

“I think in first year they come in expecting that it’s all going to be great fun and entertaining, and that they’ve picked up this idea I suppose in primary school more so it’s all about...they do all the experiments part I suppose, the easy experiment parts......So they’re kind of expecting the same, I think, when they come into first year. And then all of sudden they realise that they have to do tests and exams, and they actually have to understand the details of the experiment, it’s not just looking to see what happens” (interviewee: C).

One teacher made a comment about this in the ‘additional comments’ section of the teacher questionnaire, stating that “students have a misconception that science class is going to involve experiments with explosions and dissections only. They get this misconception from ‘open nights’ that schools run in order to attract students. Science departments are

37 Open Days refer to days when a school allows members of the public to go and see what happens there, usually in an effort to recruit pupils for the following academic year.
pressurised to put on ‘flash/bang’ magic shows and students think all classes will be like this” (TQR: male, 9 years experience).

**Increased Focus on Performance Goals in Post-Primary School**

Many students pointed out that in post-primary schools there’s more of a focus on “learning” and “taking down notes and stuff” (focus group participant: female, high motivation, 1st year). A teacher interviewee also made note of the fact that first year students become suddenly aware that there is a “pecking order” in the science classroom in post-primary school. They start to notice how important their grades are in defining them in the class (interviewee: A).

An example of some of the students’ references to this increased focus on assessment is evident in the following comment:

> “And with the tests and stuff like we have to put in like, like with our last test we had to like you know, we had to write down three experiments that we’ve done and you’ve to write down everything like” (focus group participant: male, moderate motivation, 1st year).

The students become aware that there is a set procedure or systematic approach to learning science in school:

> “Well like after we finish every chapter we have like a test on like, once we finish two or three chapters we have a test like and our science teacher always goes on about like you have to learn science like and it’s really important to learn everything in science” (focus group participant: male, moderate motivation, 1st year).

Although only a first year student, this particular pupil has already figured out that “It’s [science] kind of an important subject now in this school” (focus group participant: male, moderate motivation, 1st year).

**4.3.2 Progression in Post-Primary School**

This section will be explored under the following headings:

1. Interest in Science
2. Increased Focus on Performance
3. Increased Student Autonomy
4. Opinions on Practical Work
Interest in Science

In terms of how students’ motivation changes as they progress through post-primary school, teachers are of the belief that interest, one motivation variable, certainly declines with increasing time in school.

![Figure 4.6: Stage when students are most interested in science as perceived by teachers](image)

There is a massive drop in student interest from the beginning to end of first year from teachers’ perspectives. It can be seen however, that there are a number of teachers who believe that students’ interest in science is at its highest at the end of 3rd year, a time when students have to sit their first state examination, the Junior Certificate examination. The examination was described by some of the teachers that were interviewed as “a focus” for students which, they believe, increases students’ interest in the subject (interviewee: C).

One of the other teachers who was also interviewed described how in “first year I find that they [the students] are very enthusiastic at the start, because they are like ‘oh are we doing these experiments’ and so on. Am towards, I’d say after Christmas even, towards the end of the year, they know there is a lot of theory as well to balance out the experiments” (interviewee: B). She further explained how second year appears to be the problematic year for students’ motivation in science:

“Second year would be the year where you get a lot of unmotivation....they are at the stage where they are just trying to impress friends and their peers really” (interviewee: B).
The idea of adolescence and the effect this has on students’ motivation in science, and in school in general, was pointed out by many of the participating teachers, both in the interviews and the questionnaires:

“They are forming their identity. They’re identifying their moral standards, their ambitions, if they have any (laughs), their ambitions, their, you know, social acceptance...it’s a difficult time for them, and then you know, their subjects then start to begin to define them, their subject choices that they make at the end of first year, or half way through first year, those subjects begin to define them as people and where they are going and what they are going to be doing” (interviewee: A).

“I believe age-related issues such as puberty and giddiness cause a general slacking off in students across all subject areas around 2nd year” (TQR: male, 19 years experience).

With regard to the students’ perspective on this, some commented on how they feel that the novelty of studying science wears off after first year:

“I think I liked it more in first year because I had never done it before up until first year. I think I’m sick of it now” (focus group participant: male, low motivation, 3rd year).

Others remarked on the opposite, that is, that they like getting the chance to learn more things about science as they progress through the junior cycle:

“Yeah like, even since the start of the year, I like it more than I did in the beginning.....since second year” (focus group participant: female, high motivation, 2nd year).

“I like it more now that we’re learning more topics and that” (focus group participant: male, moderate motivation, 3rd year).

Again, there were a number of significant differences here between gender and year of study. The following table summarises these differences:
Table 4.2: Significant differences between students’ interest in science and year or gender ($N_{\text{males}} = 662, N_{\text{females}} = 759, 6$ respondents of unknown gender, $N_{1\text{st\ year}} = 482, N_{2\text{nd\ year}} = 476, N_{3\text{rd\ year}} = 457, 12$ respondents in unknown year group).

<table>
<thead>
<tr>
<th>Likert Item</th>
<th>P Value</th>
<th>Difference with gender or year</th>
<th>Most in agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>I look forward to science class</td>
<td>0.006</td>
<td>Year</td>
<td>2nd years</td>
</tr>
<tr>
<td>I would enjoy school more if there were no science classes</td>
<td>0.001</td>
<td>Year</td>
<td>3rd years</td>
</tr>
<tr>
<td>I don’t understand the point of learning science in school</td>
<td>0.001, 0.002</td>
<td>Gender</td>
<td>3rd years, Males</td>
</tr>
</tbody>
</table>

What is interesting to point out is that 2nd years are the group of students who most ‘look forward to science class’, followed by 1st year students. 3rd years are the group who least ‘look forward to science class’. Similarly, 3rd year students see less relevance in the ‘point of studying science in school’ and were most in agreement with the statement that they ‘would enjoy school more if there were no science classes’. These findings contrast strongly to the teachers’ beliefs as outlined above.

Also worth pointing out, is that there was no significant differences for how boring students find science class and year group ($p=0.738$). Students in first year, find science class equally as boring as those in 2nd or 3rd year.

**Increased Focus on Performance**

Another finding that emerged here is that not only are students aware of an increased focus on performance goals when they enter post-primary school from primary school, but students also realise that there is increased focus on assessment with each successive year in school. Some students explain how the change in their attitude is because “like it [science] got hard ‘cause all she kept saying now was ‘third year, third year’ like” (focus group participant: female, low motivation, 2nd year). A comment from a third year student described how he felt under pressure due to the increased focus on performance:

“Pressure...some of the teachers are more worried about the Junior Cert than some people in the actual...doing the Junior Cert...and they keep saying to us that it’s our test but yet they still put a load of pressure on you to do it but they say it’s your test so....” (focus group participant: male, low motivation, 3rd year).

**Increased Student Autonomy**

On a more positive note, students felt that they gained a greater sense of autonomy over their learning as they progressed from 1st year into 2nd year in school:
“She gives us more experiments to do now and it gets more interesting as she explains it more” (focus group participant: female, moderate motivation, 2nd year).

“Yeah because she…trusts you more with the experiments” (focus group participant: female, low motivation, 2nd year).

A further point to make on this is that how often students get the chance to ‘explain their own ideas about each new science topic to their teacher’ differed very significantly with year in school (p<0.001). Figure 4.7 illustrates the variance in students’ responses.

![Graph showing the percentage of students who explain their own ideas about each new science topic to the teacher by year group.](image)

Figure 4.7: Students’ responses to the statement ‘I explain my own ideas about each new science topic to the teacher’ according to year group ($N_{1st\ year} = 482$, $N_{2nd\ year} = 476$, $N_{3rd\ year} = 457$, 12 respondents in unknown year group).

Interestingly, according to the quantitative data 2nd year students ‘explain their own ideas about each new science topic to the teacher’ the most. This is followed by 1st year students. 3rd year students report doing this least often out of all of the year groups.

**Opinions on Practical Work**

Something that appeared throughout the data, from both the quantitative and qualitative instruments, is that practical work is a central aspect of science in school. Students’ liking or interest in carrying out practical work appears to change however, as students progress through school.
Many students in first year report ‘an absolute liking’\(^{38}\) of practical work in science class, with comments such as:

“I like the experiments” (focus group participant: male, high motivation, 1\(^{st}\) year).

“I just find that the experiments are fun” (SQR: female, 1\(^{st}\) year).

This absolute liking of experiments and practical work may be due to the novelty of using new equipment:

“When we were using the Bunsen Burner that was good, that was exciting like. I liked that one. There’s a lot more experiments like that, so I want to do them” (focus group participant: male, moderate motivation, 1\(^{st}\) year).

A number of students in second year referred to how their opinions about doing experiments have changed since they were in first year:

“I still like science but I’m not that pushed towards the experiments, because we do a lot...I’m not as excited on going on doing them ‘cause I know like how you do it and understanding of them” (focus group participant: female, high motivation, 2\(^{nd}\) year).

“Yeah like used be asking ‘are we doing experiments today?’, now it’s like, oh yeah, ugh, every Tuesday, isn’t it?” (focus group participant: female, low motivation, 2\(^{nd}\) year).

Furthermore, a number of older students explained how they liked practical work compared to the other work they have to do in science class, indicating their relative preference for practical work:

“Experiments... [are] just different from doing all learning and looking at the book” (focus group participant: female, high motivation, 3\(^{rd}\) year).

Teachers also commented on how they felt “students enjoy practicals and learn a lot more from them than “chalk and talk”” (TQR: female, 20 years experience). Another teacher identified practical work as somewhat of a “break” for students from listening to the teacher and taking down notes, stating that it “helps them along with the theory” (TQR: male, 14 years experience).

\(^{38}\) Absolute and relative preferences for practical work have been defined previously in section 3.6 of the literature review under the heading ‘Learning Environment’ and sub-heading ‘Practical Work’.
What students expressed that they would like in relation to practical work is to do more meaningful or authentic experiments in science in “real”, everyday contexts:

“I like science but I wish our experiments were more interesting!” (SQR: male, 1st year)

“I think it’s good when we get to go outside and do experiments” (focus group participant: female, moderate motivation, 2nd year)

“When you’re away from the desk, do you know like, somewhere else” (focus group participant: male, high motivation, 1st year).

Teachers were of a similar opinion about the prescribed practical work for the junior cycle science course. Many felt that “the 30+ experiments are something of a misnomer. In truth most are practical activities with fully predictable outcomes” (TQR: male, 29 years experience). One of the interviewee teachers explained how students become motivated when “they [the students] are really active about it and so on, but their own experiments” (interviewee: B).

On a final note, students revealed from their responses on the student questionnaire that the majority of them (80.5%) find that most/all of their science classes are spent listening to “the teacher explain science ideas”. This finding did not differ significantly with year group (p=0.146). From the teachers’ perspective, many of the teachers understand the value of doing practical work but feel that the constraints of the large curriculum and lack of resources result in the “opportunity to undertake practical work is [as] limited” (TQR: female, 12 years experience).

4.4 What Are the Predominant Factors that Influence Students’ Motivation?

4.4.1 Goals
As referred to previously, students appear to be highly motivated by performance goals, that is, by getting good grades, outperforming others, and in comparing themselves to others. Figure 4.8 below illustrates the importance that the students in this study place on conveying to others that “they are able to do well”.
It is quite clear that the majority of students, both male and female agree with this statement. This statement differs significantly with gender (p<0.001), but it does not differ significantly with year group (p=0.247). Females are more concerned about doing well in science class to impress others in comparison to male students, but 1<sup>st</sup> year students are just as likely as 2<sup>nd</sup> and 3<sup>rd</sup> year students to agree with the above statement.

What is also revealed in the data is that students appear to be surrounded by messages in their environment which focus on either performance goals or mastery goals.

Teaching practices, for example, have become more “*didactive [didactic] where you know [teachers tell their students that] this is what you need to know for the exam, write it down. There’s no opportunity to explore*” (interviewee: A). Teachers’ practices, it has been pointed out however, are influenced by society’s focus on results:

“At the end of the day you know, results count and people will look at the results and parents will be looking to see the results” (interviewee: A).
As a consequence of such a focus students appear to adopt similar goals in science class. Students’ comments related to studying, proper examination preparation and examination techniques:

“We should be given exam papers in 1st year and told this is what we are doing in 3 years time, so that it’s not a shock to us in 3rd year” (SQR: female, 3rd year).

“Could there be classes that we could not talk or learn but be separated and study science to recover what we done (did) that week maybe on Fridays 1 or 2 classes?” (SQR: female, 2nd year).

“The teacher should only put the things we actually learned on the test and give us homework we understand too” (SQR: male, 1st year).

“I think there are far far far too many experiments in science and that we should only learn what we will need for tests” (SQR: male, 1st year).

“I think our teachers should be more organised, laying out our hardbacks and experiment books. Also, I think they should have small test during the course of the year for revision” (SQR: female, 1st year).

The focus on assessment, on producing well written reports and having good notes can have a negative impact on students’ motivation to study science according to a number of teachers. One such teacher stated that this can have a profound effect on the “weaker” students:

“I feel the amount of time spent writing up the experiments for weak students, and in particular for the projects, has led to a strong decline in the students’ understanding of key topics and a decline in their interest in science” (TQR: male, 16 years experience).

Similarly, another teacher reported that:

“there comes a point, if we use the assessment that we are being encouraged to they (the students) just (clicks fingers) switch off and you lose them” (interviewee: A).

One particular student’s comment that stood out from all of the open-ended responses on the student questionnaires, highlights that at just 15 years of age, students are very aware of society’s focus on performance, and of the possible negative effects this can have:
“I don’t think that our grades in tests should be the key to getting a job but instead the knowledge that’s inside us” (SQR: male, 3rd year).

Students intuitively pick up on the goal structures of their learning environment, with a first year student remarking on how important science is as a school subject in his particular school:

“It’s kind of an important subject now in this school” (focus group participant: male, moderate motivation, 1st year).

Teachers also made comments about this, the ethos of their schools, and how this impacts on students’ subject choices for study at Leaving Certificate:

“Carry over into senior cycle does not happen in our school, practical subjects take over” (TQR: male, 9 years experience).

4.4.2 Learning Environment

As referred to above, the environment in which students are learning science in can have an impact on their motivation to study science in school. Findings that emerge from the data in relation to the learning environment will be organised under the following headings:

1. Teaching Practices
2. Information and Communication Technology
3. Task Value
4. Social Interactions

Teaching Practices

Students and teachers alike pointed out that teaching practices in the science classroom can have a major influence on students’ motivation.

Firstly, from students’ perspective many of their open-ended additional comments related to how they’d like science to be taught in a more interesting, interactive and “hands-on” way:

“I think that when the teacher is showing us experiments and not doing it it is pointless because the point of it is so we can visualise it and it is very important for kinaesthetic learners” (SQR: male, 3rd year).

“I watch the teacher do experiments instead of doing them myself in most classes this year” (SQR: male, 2nd year).
“It depends on the teacher you have, if you do understand his [or her] work or not” (SQR: female, unknown year).

“Science should be taught more ‘hands on’. We should use experiments to explain theory and study topics that are relevant to life and the world that are also relatable” (SQR: female, 2nd year).

“It would be better if we could interact more with science and it would be [more] fun if we did all fun experiments” (SQR: female, 1st year).

“Science is great but writing out experiments kills a lot of the fun” (SQR: male, 1st year).

A new way of teaching this subject should be brought in. My classes and teacher are lifeless and boring” (SQR: male, 1st year).

“Irish students see science as a very boring subject. I think it should be taught in a more interesting way” (SQR: female, 3rd year).

“Science is a good subject, but we just do it in a boring way” (SQR: male, 3rd year).

“Students’ dislike towards science is down to their teacher, their own mindsets and their peers” (SQR: male, 2nd year).

<table>
<thead>
<tr>
<th>Activity</th>
<th>All classes</th>
<th>Most classes</th>
<th>Some classes</th>
<th>Hardly any classes</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>I think about a science problem before it is explained to me by the teacher</td>
<td>13.6%</td>
<td>23.6%</td>
<td>29.2%</td>
<td>18.3%</td>
<td>15.3%</td>
</tr>
<tr>
<td>[Mean value: 2.02]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I link what I learn about science to my everyday life</td>
<td>22.2%</td>
<td>48.1%</td>
<td>17.3%</td>
<td>7.7%</td>
<td></td>
</tr>
<tr>
<td>[Mean value: 1.99]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I copy the notes the teacher gives me into my copy book</td>
<td>39.8%</td>
<td>30.8%</td>
<td>16.3%</td>
<td>6.9%</td>
<td></td>
</tr>
<tr>
<td>[Mean value: 2.91]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 4.9: Respondents’ indication as to how often they perform certain activities in their science class \((N_{\text{students}}=1427)\).

It is clear from the quantitative data, that the majority of students’ science class time is spent copying “notes the teacher gives [them] into [their] copy book[s]”.

Teachers are aware of the role they have on their students’ motivation to learn science, with one particular teacher stating that “definitely a teacher has to push, has to try and make it fun, innovative, and add as much kind of concrete imagery as well for them [the students] to understand it” (interviewee: B). A different teacher mentioned that “the biggest challenge in motivating, to motivate children, I think we have to look at ourselves as teachers. Is the quality of teaching as it should be?” (interviewee: A). This perspective was not exclusive to the teachers involved in the interviews. Other teachers pointed out in the questionnaires that “poor teaching methodologies” (TQR: male, unknown no. of years experience) are a factor that influence students’ decline in motivation in science in school.

When students were asked in the focus groups about what makes a good science teacher their comments reflected the qualities of a teacher, such as being helpful, encouraging, caring, putting effort into their teaching and having a good level of content knowledge. An example of some of the focus group comments are listed below:

“Ms. Moloney\(^{40}\) is a very good teacher. She knows her stuff like” (focus group participant: female, low motivation, 2\(^{nd}\) year).

“She’s not too strict” (focus group participant: male, moderate, 2\(^{nd}\) year).

“She understands like if you don’t get it, she’ll go straight back over it and help you and stuff. She knows by looking at your face, like if you’re looking at her as if she’s two heads, like you’ve not a clue” (focus group participant: female, high motivation, 2\(^{nd}\) year).

“Like if you need it, she’ll go over it ten times” (focus group participant: female, high motivation, 2\(^{nd}\) year).

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\(^{39}\) The mean values reported in the bar chart are based on a Likert scaling where 1 is indicative of never doing the specified task in class, and 5 refers to it being done in all classes.

\(^{40}\) Moloney is a pseudonym used to protect the identity of the teacher in question.
“Twenty, thirty...if you were stuck, she’d stay there with you for the whole class...if you were stuck she’d go through the whole chapter again” (focus group participant: female, low motivation, 2nd year).

“That they have their own notes and they are not just reading it out of the book like the whole time” (focus group participant: female, high motivation, 3rd year).

On the other hand, students also characterised what, in their opinion, makes a bad science teacher. Their characterisations made reference to poor content knowledge, not being helpful and using didactic teaching methods:

“When [teachers] don’t understand what they’re actually doing themselves” (focus group participant: female, low motivation, 2nd year).

“Someone who just reads out of the book” (focus group participant: female, high motivation, 3rd year).

“Doesn’t help you with anything” (focus group respondent: male, moderate motivation, 3rd year).

“Just rushing through the like say, rushing through the formulas and not explaining them properly...so some people wouldn’t get them like but they’d [the teacher would] just carry on with other work” (focus group respondent: male, moderate motivation, 3rd year).

Information and Communication Technology (ICT)

ICT and the impact it has on students’ learning in the classroom was something that appeared quite frequently in the data. Rather mixed views were reported on ICT regarding the advantages/disadvantages to students’ learning of science.

Firstly, many teachers acknowledged the benefits technology has in terms of teaching and being able to illustrate certain phenomenon to students. For example, one teacher stated that:

“I would think definitely technology is benefiting us [teachers] in the sense that we can show them [the students] lots of clips, like YouTube, like if I was teaching even cell division in Leaving Cert biology I can show them the stages happening” (interview: B).
A further benefit of ICT for students’ motivation in science, as identified by one particular teacher, is that it is a useful tool for communicating or relating to students with as it is “the media that they associate with” (interviewee: A).

Secondly, and rather conversely, teachers also remarked on how ICT, and the use of PowerPoints in particular, have “almost become commonplace now as well, that you know, it is replacing talk and chalk but it’s the same in every classroom around the school” (interviewee: A).

In relation to students’ use of technology for learning, one issue that emerged from the data was that learning was becoming too easy for students, as information is now very accessible and as a result, teachers explained, students don’t have to think about a science problem or work anything out for themselves. Such comments include:

“But then as well, another thing would be access to marking schemes for students that wouldn’t be very motivated and to say that they’re doing their homework, sometimes you could see the marking scheme, it’s direct on their copy” (interviewee: B).

“They are well able to use that form of media to relate to each other, but by the same token it’s almost like they are losing ability to think for themselves, like they are being swayed about something rather than them forming an opinion for themselves. Am everything is instant gratification” (interviewee: A).

“Students today are brought up in a “black box” era, where if a device stops working, “throw it away and buy a new one” [is the norm thinking/approach]. This approach does not encourage a sense of inquiry” or depth in understanding as to how things work” (TQR: female, 25 years experience).

“Students are often unwilling to learn basic concepts about science i.e. the nitty gritty – they live in a world of constant stimulation and entertainment and expect to do well without putting in the work” (TQR: female, 33 years experience).

“I also feel that students as a whole are less likely to put hard work into a subject than they used to be – students want to do things the ‘easy’ way” (TQR: female, 3 years).

One particular student comment that stood out from all of the additional comments on the student questionnaires is as follows:
“Diana\textsuperscript{41} don’t need science. I have Google!” (SQR: female, 3\textsuperscript{rd} year).

Social Interactions
Social interactions, predominantly between student and teacher, emerged from the data as being influential to students’ motivation.

Following on from some of the students’ remarks about what they believe makes a good science teacher, those students also made reference to the relationship they have with their teacher. This appeared to be a major factor for students low in motivation. One student in particular for example, who said very little throughout the entire focus group was very quick to comment on her opinions of a good science teacher. She explained that “if she’s [the teacher] nice and not always giving out and stuff” (focus group respondent: female, low motivation, 1\textsuperscript{st} year) she would consider her to be a good teacher. In a similar way, this student was the first person to share their feelings about what makes a bad science teacher, describing a bad teacher as “someone that’s always shouting and never like listens to ya and always gives ya loads of homework and stuff” (focus group participant: female, low motivation, 1\textsuperscript{st} year).

Another student who was identified as low in motivation also appeared to feel strongly about the relationship they share with their teacher, explaining that a bad teacher, in their view, is somebody that “just….they just keep giving out to you” (focus group participant: female, low motivation, 2\textsuperscript{nd} year).

When students felt that their teacher cared about them and had belief in their abilities, students felt that they wanted to keep working and live up to their teachers’ positive expectations. This was evident for students in the focus group that were highly motivated and for those that were low in motivation:

“They pushed…..they pushed you to do stuff. They just kept on to you to, it was just like they wanted you to do well so you just stayed going ahead and doing it” (focus group participant: male, low motivation, 3\textsuperscript{rd} year).

“Like I was missing for a few weeks and I came back, they [the rest of the class] had all their investigations done, and she stayed back and gave me extra notes and helped

\textsuperscript{41} This is a pseudonym.
“me...she always wants us to do our best” (focus group participants: female, high motivation, 3rd year).

Other students’ both positive and negative comments relating to the student-teacher relationship are listed below:

“I do like science but I find it hard to learn because my teacher is mean (he broke my pen!)” (SQR: female, 1st year)

“And she kind of jokes a little bit, she kind of has a laugh in the middle of class” (focus group participant: female, low motivation, 2nd year).

“She encouraged them. Yeah and she helped us. She helped us with our experiment. She stayed back after school and helped us write up the report kind of...which was good” (focus group participant: male, moderate motivation, 3rd year).

Looking at this from the teachers’ perspectives, it is clear that teachers also see the importance of developing relationships with their students. One teacher pointed out that it makes it easier for them to build a relationship with their students if they have them from first year up to third year, and hence, it makes it easier for them as teachers to motivate their students:

“Take a group on from first year and work with them...it’s very difficult to come in [in] third year when they have to pass an exam, you know, your opportunities to motivate, excite, create awe, wonder, enthuse, [are] very limited” (interviewee: A).

Teacher enthusiasm was highlighted by many as being an essential aspect of their relationship with their students in science class. For instance, one of the interviewees explained that “if you come across that you’re bored with the topic, that you dislike this topic, then that’s going to show. You have to have an enthusiasm because if it’s coming from a teacher who is feeling not enthusiastic about it and so on then that’s going to show and they’re [the students] going to get this mental switch that they don’t like it either” (interviewee: B). Another teacher commented on how, as a science teacher, “you have to...yeah at Junior Cert, in first year you have...[to] try and have a bit of charisma anyway” (interviewee: C).

**Task Value**

The final topic to be explored as part of the learning environment is that of task value. Three main issues were found to be relevant to task value from the data collected. Firstly, the junior
cycle science curriculum is perceived as overloaded and outdated, by both students and teachers. Secondly, there is a marked contrast in students’ valuing of the biology aspects of the junior cycle science course compared to the physical science aspects. Thirdly, teachers’ subject specialisms appear to have an impact on how teachers teach certain areas of the course and ultimately how students feel about these particular areas.

**Outdated Curriculum**

Teachers and students agree that the junior cycle science course “is so outdated”. In a more general sense, a high proportion of the students’ and teachers’ comments made reference to the science course as lacking relevance to their everyday lives:

- “Much of the science studied in school is not practical and useless in everyday life” (SQR: male, 3rd year)
- “The course should relate better to everyday life/tasks at home” (SQR: female, 3rd year).
- “Large syllabus to cover which could be more relevant to recent advances” (TQR: female, 5 years experience).

More specifically, it was pointed out that “topics like cancers, space, and nutrition are not discussed” (TQR: female, 1 years experience) on the junior cycle science course. One student explained how he’d “much prefer to learn about very random science topics (Higgs Boson, String Theory) as opposed to ‘old’ and definite topics that are already entirely known as facts (fulcrums, atoms)” (SQR: male, 3rd year). Similarly, another student remarked on how they think “some things like cancer and other medical sicknesses should be added to the Junior Cert” (SQR: female, 2nd year).

**Difference in Students’ Interest in the Various Aspects of Science**

As outlined previously, students tend to prefer the biology aspect of the science course, followed by chemistry. Physics is perceived to be students’ least favourite area of science. Figure 4.10 illustrates students’ interest in the various science subjects.
Figure 4.10: Students’ level of interest in the physics, chemistry and biology aspects of science \(^{42}\) \((N_{\text{students}} = 1427)\).

The quantitative data reinforces students’ open-ended responses from the questionnaires and also students’ comments in the focus groups. What is interesting to note is that there were significant differences with gender for all three of the above Likert items relating to interest in the various aspects of the combined science course. Table 4.3 summarises the main findings in relation to these significant differences, as tested using the Chi-squared test.

**Table 4.3: Significant differences relating to specific science subjects with gender \((N_{\text{males}} = 662, N_{\text{females}} = 759, 6\) respondents of unknown gender)\).**

<table>
<thead>
<tr>
<th>Likert Item</th>
<th>P Value</th>
<th>Most in Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>I think physics is an interesting part of science</td>
<td>&lt;0.001</td>
<td>Males</td>
</tr>
<tr>
<td>I think chemistry is an interesting part of science</td>
<td>0.017</td>
<td>Males</td>
</tr>
<tr>
<td>I think biology is an interesting part of science</td>
<td>&lt;0.001</td>
<td>Females</td>
</tr>
</tbody>
</table>

To highlight the gender differences for these science subjects, Figure 4.11, 4.12 and 4.13 have been created which convey the major differences in males’ and females’ subject preferences.

\(^{42}\) Mean values shown in the bar chart are based on Likert scales where a figure of 1 represents strong disagreement and 5, strong agreement.
Figure 4.11: Students’ levels of agreement with the statement ‘I think physics is an interesting part of science’ ($N_{males} = 662$, $N_{females} = 759$, 6 respondents of unknown gender).

Figure 4.12: Students’ level of agreement with the statement ‘I think chemistry is an interesting part of science’ ($N_{males} = 662$, $N_{females} = 759$, 6 respondents of unknown gender).
Figure 4.13: Students’ levels of agreement with the statement ‘I think biology is an interesting part of science’ ($N_{\text{males}} = 662$, $N_{\text{females}} = 759$, 6 respondents of unknown gender).

The main proportion of students’ open responses on the student questionnaire related to their preference for certain areas of the science course. The following list of comments is compiled from those that were mentioned in the student focus groups. These comments mirror those given by the students in the questionnaires:

“I don’t really like science. Well, I don’t mind biology. Don’t like physics and chemistry...[I’m interested in] the heart and blood systems...because my two parents are nurses so I think it just followed through” (focus group participant: male, low motivation, 3rd year).

“It kind of like…it kind of depends on what part you are doing in....like chemistry, physics or biology, on how you kind of like it...I prefer doing kind of biology than physics. I don’t really like physics now” (focus group participant: female, high motivation, 2nd year).

“Yeah physics is really hard. Biology is way more fun” (focus group participant: female, low motivation, 2nd year).

“Am I think I only like biology, because that’s like the only thing I get... the rest I don’t” (focus group participant: female, low motivation, 3rd year).
**Teachers’ Subject Areas**

Similar to students’ disliking of physics on the junior cycle course, it appears that teachers feel the same way. When asked on the questionnaire what aspect of the junior cycle science course was teachers’ least favourite topic to teach, the vast majority of respondents selected a physics topic: magnetism, electricity and electrics.

When teachers’ explained why it is their least favourite topic to teach, the most commonly given response related to teachers’ lack of expertise in this area. Such explanations include:

- “Not in my primary degree. Did not study physics for the Leaving Certificate” (magnetism/electricity/electronics) (TQR: female, 6 years experience).

- “I have the least experience in it” (magnetism/electricity/electronics) (TQR: female, 3 years experience).

- “Physics isn’t one of main subject areas for Leaving Cert” (magnetism/electricity/electronics) (TQR: female, 5 years experience).

- “I’ve less background knowledge” (magnetism/electricity/electronics) (TQR: female, 20 years experience).

- “I have always found it difficult to get across to students Ohm’s law and the concept of current electricity is a difficult one for weaker students to grasp. Perhaps the fact that my background is biology/chemistry doesn’t help” (magnetism/electricity/electronics) (TQR: female, 33 years experience).

- “My own knowledge of electricity and electronics is limited” (magnetism/electricity/electronics) (TQR: male, 29 years experience).

- “Physics is not my area” (magnetism/electricity/electronics) (TQR: female, unknown years of experience).

- “Physics education in college was minimal. Electricity was an “option” topic for my Junior Cert in 2003. I did not do Leaving Cert physics - not confident in electronics” (magnetism/electricity/electronics) (TQR: female, 4 years experience).

- “Physics is not my strongest area” (magnetism/electricity/electronics) (TQR: female, 15 years experience).
“It is an area that I do not have confidence in my complete knowledge and understanding especially electricity” (magnetism/electricity/electronics) (TQR: male, 27 years experience).

“Physics: don’t fully understand what’s going on myself” (magnetism/electricity/electronics) (TQR: female, 20 years experience).

What may be worth pointing out here is that, of the above 11 comments, made by teachers of varying degrees of experience, only two of those comments were made by male teachers. There was only one comment made by a teacher relating to their difficulty in teaching a biology topic: “I am least confident in terms of my own knowledge in this area” (skeletal/muscular system) (TQR: female, 7 years experience).

On a final note, this subject preference or lack of can have an impact on students’ liking of these subjects as pointed out clearly by one teacher:

“Teachers, mostly unintentionally, will promote their own area of expertise, to the detriment of the other branches” (TQR: male, 29 years experience).

4.4.3 Science Self-Concept

What emerges most clearly about students’ sense of self-concept from the data is that teachers believe that this is the key to students’ engagement or disengagement in science. When asked in the teacher interview ‘is it possible to re-engage disengaged students in science’, the researcher got this response:

“Definitely….They can lose kind of belief in themselves as well. If there is a chapter or a topic that they just find very hard, and I understand that they are not going to click with a topic straight away, but am, you have to give them the belief back. If you’re going to move on and forget about them, they are going to forget about it. They’ll stay disengaged. But keep reinforcing them, saying they are well able and any little answer that they call out that’s right make sure to be positive about it and acknowledge that they have gotten answers right. Am yeah, you would see students turning around. It’s just all about positive reinforcement” (interviewee: B).

The influence of science self-concept on students’ motivation has been reviewed in detail from the students’ perspective previously in the chapter. Hence it will not be discussed here further.
4.4.4 Family Background

A final factor that emerged from the data as being influential on students’ motivation in science is family background. In fact all three teacher interviewees identified family background as the biggest challenge in motivating students to study science in school:

“Well I suppose sometimes it depends on their family background, definitely I think. If there’s somebody there motivating them or asking them about their homework at home or asking them about science or showing an interest in science, it kind of motivates them a little bit more. I do think that has a huge part to play because you have some kids that have no interest and the parents when they come to the parent teacher meetings, they’re saying ‘oh sure they’re passing’ or they are, you know, ‘oh and I’m not too concerned’. Whereas you might have other parents that are pushing them a little bit more. You’d know that they would be signing their journal or checking their homework” (interviewee: C).

“Support at home….Definitely, am. Like no homework, it’s not seen as an issue even if a letter would go home to some students’ [parents]. So background really does affect it. Am. Like for example as I was saying with the Junior Cert projects, some didn’t really care about not handing them in and so on and that was because their parents didn’t care. There was going to be no consequence at home. Am but, everything is being done in school like there’s stimulation, there’s posters, there’s videos, there’s all sorts of demonstrations trying to be done to be motivating them but it’s like there’s the switch. So I do think external environment really has…a huge impact” (interview: B).

“Am.. and yeah social background has ah ah lot to do with it” (interviewee: A).

It was also referred to by teachers in the ‘additional comments’ section of the teacher questionnaire:

“Parents’ lack of interest in their [the students] study and progress” (TQR: female, 30 years experience).

“Their parents can sometimes pass on a very negative attitude that science is very difficult and will never be understood. Therefore, students have little motivation and a negative view of science” (TQR: female, 3 years experience).
“Parental attitude” (TQR: female, 30 years experience).

“This school is academic with a higher than average attainment rate. Most students are motivated and come from stable family units where huge emphasis is placed on education.” (TQR: male, 5 years experience).

“Some parents who did not do science at school feel their child will not be any good at it” (TQR: female, 30 years experience).

4.5 Summary of Main Findings

- Students are not particularly interested in junior cycle science.
- Science, in the main, is perceived as difficult.
- In general, biology is considered the most interesting and easiest part of the science course.
- Male students prefer the physics aspects of the science course, females prefer biology.
- Students experience an increase in focus on performance goals as they transition from primary school into post-primary school, and also as they progress from first year to third year in post-primary school.
- Students are highly motivated by performance goals.
- Overall, students have a low science self-concept. But, males tend to have a significantly higher self-concept than their female counterparts.
- Students gain false expectations of what science is “really like” in post-primary school from Open Days and their (limited) experience of science in primary school.
- 2nd year is identified by teachers as the point where students “switch off” in science class. However, students reported being most interested in science class in 2nd year, when compared to 1st and 3rd year students.
- Goals, learning environment, self-concept and family background are identified as the main factors affecting Irish students’ motivation in junior cycle science.
- Teachers tend to promote their own areas of expertise to the detriment of the other science subject areas.
- ICT affects students’ motivation to study science. From these data it is not clear if it impacts positively or negatively.
• Practical work in science class is preferred to ‘normal’ theory work, particularly as students progress through the junior cycle. It is not seen as a major motivational factor.

4.6 Conclusion

The data obtained from the completed teacher and student questionnaires have been analysed using IBM SPSS Statistics (version 21) and all findings have been represented using a variation of graphs, tables and charts. The qualitative data from phase one and two have been reported on, triangulating the findings from the questionnaires. The results presented here will be discussed in detail in the following chapter.
5.1 Introduction
This chapter will be structured according to the research questions, as presented in the results chapter, where the relevant findings will be discussed under the following headings:

- In what way do junior cycle science students’ motivational orientations differ in the first three years of post-primary education in Ireland?
- What are the main factors that affect students’ motivation in junior cycle science in Ireland?
- Are Irish students motivated to study junior cycle science in school?

What is somewhat different about the layout of this chapter to that of the results chapter is that the first research question will be answered last.

5.2 In What Way do Junior Cycle Science Students’ Motivational Orientations Differ in the First Three Years of Post-Primary Education in Ireland?
For clarity and coherence purposes, any findings relating to variations in students’ motivation to study science in school as they progress through the junior cycle will be discussed in terms of the differences apparent per year group. [It should be noted that all quantitative data gathered relating to first, second and third year groups were collected at one point in time and hence the data do not represent longitudinal data, rather, general information about students’ motivational orientations in the first three years of study in post-primary school science]. Hence this section will be split into three main sections: first year students, second year students and third year students.

5.2.1 First Year Students
Rather mixed feelings were reported by the first year students regarding their motivation towards science in school. Four main themes emerged relating to first year students’ changing interests and feelings towards school science. These themes are: the transition from primary school, the introduction to novel, exciting science equipment and experiments, the increased awareness of performance goals, and students’ sense of science self-concept.
5.2.1.1 Transition from Primary School.

Transition in education in general, whether from pre-school to primary, or from primary to post-primary school, is a time of considerable change and readjustment for many students (Ferguson and Fraser 1998). Results from this research study corroborate these findings. Students reported experiencing great differences in their science education in post-primary school compared to primary school, and consequently, this affected certain aspects of their motivation to study science in post-primary school.

Some students reported really enjoying learning science in post-primary school, particularly because they felt they never had the opportunity to learn about science concepts in primary school. They commented on how they only “did it in 6th class...well, .. every two weeks or something” and that really they felt that they “didn’t do a lot of science in primary school, like it wouldn’t be one of the subjects that [they] did a lot”. Even students in second and third year reported that they “hardly ever did science in primary school”, this is despite its introduction into the primary school curriculum in 2003, and its presence in every year from 1st to 6th class.

When students remarked on what they did do when they studied science in primary school, all responses related to carrying out experiments. This finding appears to be in conflict with what numerous researchers have found. These researchers have been questioning if it is the lack of investigative work that is turning students off science before their transition to post-primary school (Ponchaud 2001; Murphy and Beggs 2005; Varley et al. 2008a). Students’ descriptions about doing “a lot of experiments” in primary school clearly indicate that they did not feel that there was a lack of investigative work in their study of science in primary school.

However, students did report that they “didn’t really learn much about them [the experiments]” and as result, some students found the experiments “kind of hard to understand”. It is pointed out in the primary science curriculum that “the development of children’s ideas is central to science education” in primary school (NCCA 1999, p.6) and that “a key characterisation of learning within SESE is the involvement of the child in the active exploration and investigation of all these environments” (ibid, p.2). The intention of the curriculum is that, through “well-planned investigations, children’s natural curiosity is channelled and they are equipped with the strategies and processes to develop scientific ideas

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43 Social, Environment and Scientific Education (SESE) is part of the primary school curriculum which incorporates science education.

44 Environments here refer to the natural environments and human environments that primary school students learn about in the SESE curriculum.
and concepts” (ibid, p.6). There appears to be inconsistencies between the aims of primary science and the realities of what is implemented, according to the students’ accounts. What is possibly worth pointing out here is that both comments relating to the difficulty of understanding science concepts in primary school were both made by first year students exhibiting high levels of motivation in science. It is not clear if the other students, those moderate and low in motivation, would also have preferred to be learning more about the “loads of experiments” that they conducted in primary school.

Another important point to consider here is the level of science training or science expertise of primary school teachers. Research has shown that many primary school teachers lack preparedness for teaching science and convey a reluctance to teach it to their primary school students (Appleton 2003). Further research on Irish students’ transition from primary school to post-primary school, relating to the issues of teaching and learning in science, found that primary teachers feel significantly less confident in their teaching of science than their post-primary school counterparts due to their lack of science teacher training (Blackwell 2012). This, Blackwell (2012) states, “can lead to issues for pupil learning in particular areas of science prior to and upon transition to post-primary school” (p.ii).

Furthermore, it has been stated that “young children approach science activities with ideas that they have formed from previous experiences” (NCCA 1999, p.6). Perhaps, students’ lack of study or depth of study in primary school accounts for why many first year students perceive science to be a rather difficult subject in post-primary school. It is important to remember that, in this research study, 1st year students were the group of students that agreed most with the statement ‘science is a difficult subject’.

It was suggested by some of the teachers in the study that the reason why they believe students find science so difficult is because of the specific language used in science and in science texts. Certainly, a plausible explanation for this is that students may not have been introduced to much scientific language in their limited study of science in primary school. One particular 1st year student commented on how for science tests in post-primary school “it’s hard to learn everything ‘cause there’s so many different topics and everything...like the definitions”. He further explained how they “have to put in like, like with our last test we had to write down three experiments that we’ve done and you’ve to write down everything like”. Students appear to be quite aware that there is certain terminology associated with science, and that these terms have to be remembered and “written down” for their tests. A different
student described how he thinks that “experiments are good” but he doesn’t “like learning formulas and ingredients in experiments”. This statement is a particularly good example as it highlights the importance placed on scientific language in science assessments. The researcher is fully aware that the student is referring to the apparatus or chemicals involved in experiments when he used the term ‘ingredients’. However, the term ingredient is not necessarily considered “correct” scientific terminology, and as a result, may not be eligible for full marks in a science examination. To reinforce this, the ‘Junior Certificate Science Guidelines for Teachers’ handbook states that “for effective communication, information must be accurate and clearly presented, using the language of science as appropriate” (NCCA 2007, p.16).

Furthermore, language, it has been stated, “is a major barrier, if not the major barrier to most pupils in learning science” (Wellington and Osborne 2001, p.2). A recent study carried out in Ireland, based on the role that language plays in science education at junior cycle level, found that Irish science teachers are aware that the language of science is a barrier to students’ acquisition of scientific knowledge and understanding (Ryan 2015). However, such teachers’ awareness was limited to the technical language of science e.g. isotope (ibid). What is interesting about this study, is that is has shown that many of the non-technical words used by science teachers (e.g. devise, effect, solution) are not readily accessible to most of the students in their class. This is something that teachers need to be more aware of so that they can prevent language from being a barrier to their students’ study of science in school.

In summation, the first year students in this study were found to be relatively interested in science in their first year in post-primary school, despite finding it more difficult than in primary school.

5.2.1.2 Introduction to Novel, Exciting Science Equipment and Experiments

One of the suggestions as to why some of the first year students enjoyed learning science in post-primary school was due to the practical aspect of the course. Some of the first year students described how they thought that “the experiments are fun”. Others made reference to how they enjoyed carrying out science experiments, in a new environment, that is, in the science laboratory, and using novel equipment, such as the Bunsen burner in the following example:
“When we’re doing the experiments like, there’s a lot of good, fun experiments you do like. When we’re using the Bunsen burner, that was good, that was exciting like. I liked that one”.

Interestingly, it has been suggested that Irish primary school students consider the Bunsen burner as an important piece of apparatus that characterises doing post-primary school science (Varley et al. 2008a). Abrahams (2009) also claimed that as it is students’ first opportunity in grade 7 (1st year Irish equivalent) to use scientific equipment and/or materials, this is something that they appear to like about practical work in an “absolute” sense.

Another thing to note from the data is that first year students appear to expect to like science when they enter post-primary school. They are looking forward to doing all the “cool experiments” that they see being performed on Open Days in the school. According to Galton (2002), pre-transfer induction visits to post-primary schools often provide primary pupils with unreasonably high expectations of what post-primary school science will entail. Braund and Driver (2002) further highlight the issue of these “taster” experiences in forming high expectations of post-primary school science prior to transition. They demonstrated that visiting laboratories and observing dramatic and exciting experiments appeared to be typical of the experiences encountered by primary school pupils on their pre-transfer visit, such as at Open Days (ibid). Although the majority of the students who participated in the focus groups in this study appeared to like post-primary school science, some had become somewhat disillusioned by the initial attraction of practical work, and realised that “when you go in [to secondary school] it’s only once a week, you just do one experiment like”. Primary school students, it has been argued, hold extremely high expectations of post-primary school science and these expectations are often not realised following the transition (Blackwell 2012).

5.2.1.3 Increased Awareness of Performance Goals

A further reason as to why some of the students’ expectations do not materialise when they transition into post-primary school is due to the increased academic demands of the new school and the school culture. It is quite clear from the results of this study that students experience a dramatic change in the school culture that they are used to, when they move from primary school into post-primary school. Evidence of this is found in students’ comments when they say that “there’s more learning” and “it’s hard when it comes to tests.

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45 Absolute here refers to students’ liking of practical work using terms such as it is fun, it is exciting, I just like it. This is in contrast to students’ relative preference for liking practical work which would be indicated with comparative terms such as better than, less than, more than.
and stuff and it’s hard to revise”. The frequency of the word ‘test’ in first year students’ responses, mostly in the focus groups, but also in the questionnaires (e.g. “I think there are far far far too many experiments in science and that we should only learn what we will need for tests”) reveal that there is more of a focus now on performance and on grades. Rather than doing experiments and playing games all of the time, the 1st year focus group participants described how this year, “we don’t do anything like that, just taking down notes and studying” and “writing out experiments” which “kills a lot of the fun”. Having to carry out more repetitive tests and training to recall facts in post-primary school science tends to be one of the reasons why 1st year students change their (positive) view about science in post-primary school (Murphy and Beggs 2005).

Furthermore, other research studies have shown that when students move from the last year of elementary school (equivalent to primary) into middle school (post-primary school), a particularly negative pattern of motivational, affective, and achievement outcomes is associated with a perceived decrease in the mastery goal structure of the classroom across the transition (Wigfield et al. 1987; Eccles and Midgley 1988, 1990; Lepper et al. 1997; Covington 2000; Urdan and Midgley 2003). The difference in the types of tasks, the authority structure and the evaluation strategies can convey very different messages to the students regarding the general goal structure of the new post-primary school classroom.

What is indicative of the fact that the 1st year students may have adopted a performance goal orientation since their transition into post-primary school is that almost 90% of the 1st year student questionnaire respondents (88.8%) agreed that their “main goal in science class is to get a good grade”. A mere 3.4% of 1st years disagreed with this statement. Although it is not clear what students’ goal orientations were before they entered post-primary school, it appears from the responses to the focus groups that there was not as much of a focus on “tests” in primary school science. Tests, grades or assessments of any sort were not mentioned once, by any of the focus group respondents, when asked about their experience of science in primary school. Typical comments when describing their primary science experiences include: “well it [science] was kind of more fun in primary school” and “like we just did mostly everything on the whiteboard, so we didn’t, like take down loads of stuff”.

In addition to this, one of the 1st year student’s comments on the student questionnaire implied that it was normal, in post-primary school, for her fellow classmates to get their science tests back and to compare them with everyone else (e.g. “I don’t like [it] when people get their test
back [and] they show me their answer. I get upset then.”). A teacher interviewee also alluded to this phenomenon; she explained how:

“They [students] come into first year, they’re full of wonderment, they’re full of excitement, they’re brimming with enthusiasm. And literally by the time they’ve sat their first test, they know where they stand in the pecking order in the classroom”.

She further elaborates on how this affects the students:

“you know, they can see themselves where they stand in the pecking order, despite differentiating your lessons, despite encouraging, you know trying to assess in different ways so it’s not so obvious, they still know and are aware blatantly where they stand. And there comes a point, if we use the assessment that we are being encouraged to they just (click fingers) switch off and you lose them”.

Further results from the student questionnaires highlight that 1st year students are aware of the importance of results and they do care “if the other students in [their] class do better than [them] in science tests” (59.7%). This more competitive environment of post-primary school, Galton et al. (1999) suggest, creates uncertainty for many students, often resulting in a loss of self-esteem or self-belief. Findings relating to students’ self-beliefs from the study will be explored below.

5.2.1.4 Science Self-Concept

1st year students’ response to the statement ‘I am not as good at science as most of the other pupils in my class’ revealed some interesting results. A large majority of the 1st year students (40.6%) disagreed with this statement, but almost an equally large proportion were unsure (33.6%). 1st year students showed the highest levels of uncertainty here, in comparison to their 2nd and 3rd year counterparts.

It has been argued that students may fall behind in science class because they are afraid of conveying their weaknesses to others: this can occur, for instance, in situations where the new learning is difficult, or where there is concern about being put in, or moved to, a low set or ability stream (Galton et al. 1999). A typical response for some students is to withdraw from the struggle and persuade themselves and others that success is about ability rather than effort (Chaplain 1996). One such example is evident in the following 1st year student’s open-response from the student questionnaire, who stated that “studying hard still might not make you good at the subject, some people just naturally understand it.”
In addition to this it was also noticed in the current study that one particular 1st year student in the focus groups, who was considered as low in motivation in science, remarked on how she “[doesn’t] really like science normally ‘cause like mostly the teacher always puts you with a bad partner and the partner is always doing everything on his own, and like he doesn’t want to let you do anything”. It is apparent that this student is aware of her abilities in comparison to others in the classroom. She has picked up that she is “always” matched with a partner who does “everything” and who doesn’t want to let her do anything. She is aware how others feel about her ability as they don’t trust her to get involved in doing experiments, and as a result she “[doesn’t] really like science”. Interestingly, the very same student described how she used to enjoy “playing games” in primary science, but now she is wondering “is there ever a chance that you know like the science would stop and it would be an option?”.

One of the teacher interviewees stated that it is “positive reinforcement” that is key to keeping students engaged in science class. She described how important it is to “give them the belief back” if they start to “lose kind of belief in themselves”. The ways in which she suggests doing this is by “saying they are well able and any little answer that they call out that’s right make sure to be positive about it and acknowledge that they have gotten answers right”. Unsurprisingly, the student in question did not have this particular teacher as her science teacher. Rather than focusing on positively reinforcing the student, the student’s lack of ability is constantly being communicated to her in the way her science “teacher always puts [her] with a bad partner” who is “always doing everything on his own, and ...he doesn’t want to let [her] do anything”. Research suggests that students who are less self-confident and have a more negative view of themselves experience more difficulties when making the transition from primary school into post-primary school (Smyth et al. 2006). It cannot be confirmed if this student did suffer from low self-concept in science and self-esteem before she attended post-primary school. However, it would not be surprising if this student experienced diminished self-belief and self-concept in science due to the competitive environment of post-primary school.

In sum, a number of research studies (Campbell 2001; Murphy and Beggs 2005 and Varley et al. 2008b) have stated it is the transition from primary to post-primary school that is one of the deciding factors that contribute to students’ lack of interest in the uptake of science subjects at second-level. Further evaluation of the different motivational orientations and interests of 2nd and 3rd year students is required before making such a claim about the students
involved in this study. Hence, the experiences of 2\textsuperscript{nd} year students will now be discussed below.

5.2.2 Second Year Students
First and foremost, what emerged most strongly from the data regarding 2\textsuperscript{nd} year students’ motivation, is the widespread belief, by teachers, that second year is the problematic year in motivating students to study science in school. Second year is often characterised by teachers as “one of ‘drift’ on the part of students” (Smyth \textit{et al}. 2004, p.2). One teacher interviewee stated that “second year would be the year where you would get a lot of unmotivation” and explained that it was because students “are at that stage where they are just trying to impress friends and their peers really”. This is reinforced by a longitudinal study that was carried out in Ireland on students’ experiences in school as they progress through the junior cycle. Findings from this study identify second year as the critical point where students either engage or disengage from school, and this appears to be more of a critical issue for males than female students (Smyth \textit{et al}. 2006). Much literature has stated that there appears to be a general decline in 2\textsuperscript{nd} year students’ interest and attitude towards school in general (Epstein and McPartland 1976; Eccles & Wigfield 1992). However, Smyth \textit{et al}. (2006) specifically found in their study that Irish students became somewhat less interested in science over the course of first year and over their move into second year.

These findings contrast strongly with the results obtained in the current research study, at least from the students’ perspective. The quantitative data from the student questionnaires highlight that students in 2\textsuperscript{nd} year reported being most interested in science, look forward to science class more and find it less difficult than their 1\textsuperscript{st} year and 3\textsuperscript{rd} year counterparts. In fact, there were significant differences for all three of the above scales and year group (i.e. ‘I look forward to science class’ p=0.006, ‘science in school is interesting’ p=0.004, and ‘science is a difficult subject’ p=0.005) and it is also important to remember that the sample size of students in this study was rather large (n=1427). This is a significant finding which may reflect a change in schools since the previous studies, which were carried out over 10 years ago.

Many of the reasons provided by the teachers as to why students in 2\textsuperscript{nd} year are considered to lack motivation are attributed to students’ personal transition through adolescence. Open responses from the teacher questionnaires report that “age-related issues such as puberty and giddiness cause a general slacking off in students across all subject areas around 2\textsuperscript{nd} year.”
An interviewee from phase two of the project also commented on how students at this stage are “forming their identity” and that “it’s a difficult time for them”. She explains how they are “identifying their moral standards…their ambitions…and their social acceptance”. This has been widely documented in the literature, that, for instance, it is at this point in students’ life that social relationships with peers assume a prominent role and it is important that they feel connected to a peer network in school (Hawkins and Berndt 1985; Juvonen and Cardigan 2002).

It can be argued however, that this does not necessarily equate to students’ declining interest in or motivation towards science declining in school at the same period. Undoubtedly, students’ motivation may be affected by the culture of the school, even the gender of the school, and the popularity of science amongst peers (Barker and Gump 1964; Talton & Simpson 1985; Breakwell and Beardsell 1992). Yet, it is not entirely valid to say that if students become more interested in ‘social relationships’ in their 2nd year of post-primary school, that they are no longer interested in certain subjects, such as science. Perhaps, the author suggests, it is that students’ behaviour is more difficult to manage for teachers during this year. It may be more difficult and require more effort for teachers to “catch” students’ situational interests in class to relate the science content to the students’ lives; as one interviewee mentioned, students are trying to define themselves at this point and they overly aware of their image and identity among their peers.

Eccles et al. (1993) elaborate on this point in their investigation of ‘person-environment fit’ for early adolescents in school. They argue the importance of looking at the fit between the needs of early adolescents and the opportunities afforded them in the traditional high school environment. A poor fit, they suggest, would help explain the declines in motivation associated with the transition to junior high school (ibid). Earlier research from Higgins and Parsons (1983) reinforce this point. They suggest that some of the motivational problems seen at early adolescence may be a consequence of the negative changes in the school environment rather than characteristics of the developmental period of adolescence per se.

It is worth considering here that great emphasis is placed on teacher control and discipline in post-primary school, as somewhat alluded to previously when describing the change in goals in post-primary school from those in primary school. It has been reported that there are few

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46 Junior high school refers to students in their second last year in American high school, typically aged between 16-17 years old.
opportunities for decision making, choice and self-management for students in science classes in post-primary school (Brophy and Everston 1976). To elaborate on this further, Brophy and Everston (1976) found that junior high school teachers spend more time maintaining order and less time actually teaching than do elementary school teachers. Smyth et al. (2006) reported findings consistent with this, but for students more similar in age to those in the current study. Smyth et al. (2006) found that the quality of interaction between teachers and students change as students move from first year into second year with less emphasis on praise and reinforcement and a greater prevalence of being ‘given out to’.

Interestingly, when 2nd year students were asked in the focus groups about what they believe characterises a bad science teacher many of their responses alluded to their teacher “giving out” and not being empathetic if the students don’t understand something, for example:

“They [bad teachers] just...they just keep giving out to you”.

“They kind of keep going on even when you still don’t understand what’s going on beforehand, and you get lost in the chapter and stuff”.

“And they are going on....when you don’t understand something and they don’t go back and explain it to you”.

On the contrary, when 2nd year students described what they thought would make a good science teacher, they referred to somebody that is relatable, understanding and caring. Such 2nd year students’ responses include:

“She’s really young and everything”

“She understands like if you don’t get it, she’ll go straight back over it and help you out and stuff. She knows by looking at your face, like if you’re looking at her as if she’s got two heads”.

Another theme that emerged from the 2nd year students’ responses in the focus groups is that they enjoyed the fact they were being given more autonomy over their learning. One student remarked how he liked that “we all get to do the experiments. She [their teacher] just doesn’t show us how it’s done. She lets us do it ourselves. So it’s good that way”. A different focus group participant also stated that their teacher “trusts you more with the experiments” now that they are in second year. It is worth pointing out here, that the students involved in this focus group were from one particular 2nd year class group, and hence, all had the same
teacher. These findings are therefore not indicative of all second year students within the school, nor within the whole study. Eccles et al.’s (1993) study on American students’ development in school during adolescence found autonomy to be one the major needs that adolescents are trying to satisfy during this period. Furthermore, Eccles et al. (1993) observed in their study that the fit between adolescents’ desire for autonomy and their perception of the extent to which their classroom afforded them opportunities to engage in autonomous behaviour had decreased over the junior high school transition.

Further research is required into the area of teaching practices employed by Irish teachers teaching 2nd year class groups and whether the interactions between students and teachers differ significantly for this year group, as students tend to go through the early stages of adolescence in this year.

On a final point about 2nd year students and their motivational orientations, is that perhaps 2nd year students become overly or inaccurately confident in their abilities and self-concept. Although, it was not significantly different (p=0.452) from the 1st year and 3rd year responses, 2nd year students were the group of students that were in most agreement (with 61.2% of respondents agreeing) that ‘science has lots of ideas that [they] can understand’. There was other, but rather minimal, data to suggest 2nd year students’ high levels of self-confidence. One female 2nd year student stated that “I don’t find science hard and I don’t need to do much studying for it” in the additional comments section of the student questionnaire. The reason why the researcher thinks that this may be an issue relating to second years’ motivation levels and orientations is because of anecdotal evidence from teachers alluding to how second years don’t feel “afraid” in post-primary school anymore, they exhibit great confidence and they start to “test” teachers. O’Brien’s study (2004) identified some interesting findings in relation to this. O’Brien (2004) found that students in their last year in primary school were regarded as responsible and grown up. However, O’Brien (2004) also discovered that following transition to first year in post-primary school, students were now at the bottom of the school social ladder and experiencing less control and freedom over their movements. When students enter second year, they start to regain that feeling of responsibility and control. This was not explored in great detail in the current research project, but perhaps there is also a need for further research in this area in Ireland.

To conclude this particular section of the discussion, based on second year students’ motivations and how they are perceived to be somewhat different to those in first year, the
results from this study convey that students themselves do not report being less interested in science than they were in 1st year. In fact, they look forward to science classes more and find the science content less difficult. Teachers’ perspectives are what differ here. They feel that students tend to “switch-off” from science in this year because of other social interests and due to their changing hormones. Consequently, they report how difficult it is to “rein them back in” in science class. The researcher proposes that students’ are not necessarily disinterested in science in second year, as the teachers claim, but are more difficult to manage, in comparison to 1st year students, who are feeling less confident about most things following their transition from primary school, and also in comparison to 3rd year students, who have the “focus” of the Junior Certificate examination at the end of the year. The researcher argues that 2nd year students are experiencing a change in their needs, that is primarily for more autonomy over their own learning, and teachers need to account for this in their teaching. However, the researcher is aware that more research needs to be carried out on this before this view can be stated definitively.

5.2.3 Third Year Students

With regards to how 3rd year students’ motivation in science may change, much of the data points to one single factor in causing such changes, the state examination at the end of the year, namely the Junior Certificate. This can be highly motivating for some, but can have quite the opposite effect for other students as will be explored here in detail.

To begin, 3rd year students’ interest in science appears to be quite low, according to the quantitative data from the student questionnaires. Despite a relatively high proportion of students (66.7%) agreeing that ‘science in school is interesting’, over three quarters of all 3rd year students surveyed (76.4%) claimed that they “don’t understand the point of studying science in school”. This statistic is significantly different (p=0.001) from those that agreed with this statement in 1st year (63.5%) and those in 2nd year (73.0%). Furthermore, the highest proportion of students that thought that they would ‘enjoy school more if there were no science lessons’ were 3rd year students (64.5%). This proportion is in contrast to those that agreed with this statement in 2nd year (57.1%) and those in 1st year (51.8%).

Again, similar to the findings in relation to 2nd year students, there are disparities among what students convey about their interest in science and in what teachers think. Many teachers indicated that students became interested again in science in 3rd year, after their apparent decline in interest and motivation in general in second year. Some of the interviewee teachers
stated that “third year, in my opinion, they come around to it, they see the relevance to it in the future a bit more….third year it’s a little bit more motivated again” because students “have no focus in second year anyway. There’s not like there’s any exam that year. There’s not like there’s anything specific that they are focusing towards in school like”. Teachers feel that the state examination at the end of 3rd year is a “focus” for students, and feel that it directs their thinking towards needing to learn science for their examination. This will be referred to again in the following paragraphs.

Looking at the students’ perspectives in terms of how difficult 3rd year students perceive science in school to be, 60.1% of 3rd year students believe that “science is a difficult subject”. 2nd years on the other hand, view it as being somewhat less difficult, with 54.9% of 2nd years agreeing with the above statement. With this in mind, what is interesting to point out is that over three quarters (76.1%) of all 3rd year students who completed the student questionnaire indicated that they “would like to study science for their Leaving Certificate”. This differs significantly with year group (p<0.001) where 55.1% of second years reported wanting to study a science subject for their Leaving Certificate, and an even lower number of 1st years (45.1%). It can be argued that it is likely that more 3rd year students would be thinking of studying science subjects for their Leaving Certificate, as they are at the stage where they will soon have to make those choices, which would account for their higher percentage. Other students, as this particular student pointed out, find that “it is hard to answer after only one year of science” and that some students “don’t think that far ahead”. On the contrary, one could also argue that if students really love studying science in school, that is, if they have a personal interest in it, it would be clear to them already that they would like to further their study of science in the future. Examples of such student responses include:

“Science is an interesting subject to learn when you want to go on and do medicine.”

“I would like to study biology because I want to be a nurse.”

“I do not like science and I will never need it because I want to be a primary school teacher.”

“Science is a good subject to become a mechanic, so I’m going to try study science harder.”

All except one of the above comments were made by 2nd year students. It is the awareness of the importance of science in society, and that “you kind of need it a lot... for jobs and stuff”
that appears to be the reason why students would like to study science for their Leaving Certificate, as opposed to their ‘absolute’ liking or interest in the subject.

A further issue to highlight is that teachers appear to change their teaching practices for 3rd year students. 3rd years were the group that least often had the opportunity in class to “explain [their] ideas about each new science topic to the teacher” and almost 60% of students (58.5%) revealed that they hardly ever or never “do experiments to test out [their] ideas on a science problem”. What is also worth drawing attention to is that students’ liking for practical work in science in an ‘absolute’ sense seems to wane in 3rd year. In contrast to students’ comments in 1st year about how they find the experiments “fun”, 3rd year students’ comments reflect a more ‘relative’ preference for practical work in science class, implying that they merely prefer doing experiments than the other activities that they usually do. An example of this comes from one such 3rd year student that described how the “experiments..[are] just different from doing all learning and looking at the book”.

In essence, what the above findings suggest is that teaching and learning in 3rd year is strongly coloured by the impending high stakes examination. Smyth and Banks (2012) claim this brings about a reduction in more engaging, student-centred activities within the Irish classroom. Smyth and Banks’ (2012) claims are reinforced by findings from studies that have been carried out in other high-stakes school systems (Shepard and Dougherty 1991; Au 2007).

Teachers involved in this study commented on the pressure they felt from society about achieving results, and thus encouraging them to ‘teach to the test’. This, Gordon and Reese (1997) state, motivates students to learn test-taking skills rather than higher order cognitive skills. Students’ desire for improving their test-taking skills is evident from the 3rd year data, to some extent, with students suggesting that they “should be given exam papers in 1st year and told this is what [they] are doing in 3 years time, so that it’s not a shock to [them] in 3rd year”.

It must be acknowledged that not all students felt this way, and some reported feeling under a lot of pressure about the constant reminder they get as 3rd year students about the impending examination:

“Some of the teachers are more worried about the Junior Cert than some people in the actual, doing the Junior Cert... and they keep saying to us that it’s our test but yet they still put a load of pressure on you to do it but they say it’s your test so....”
“Just sick of [3rd year]”

“We are expected to like study all the time”.

Rather contradictory findings emerge from the current study on whether or not the “focus”, or threat, of the Junior Certificate examination actually motivates or demotivates students. What is clear, however, is that it certainly has an effect on both students and teachers alike. Perhaps, the researcher suggests, drawing on implications made in Smyth and Banks’ (2012) study, is that as students further progress through post-primary school towards the ultimate high-stakes examination, the Leaving Certificate, is when most students may show a stronger preference for a more narrowly focused approach to examination preparation. Smyth and Banks (2012) state that when students approach their final year in post-primary school they feel that they require their teachers to act as effective ‘coaches’ in test preparation rather than providing access to the broader educational activities that they previously found engaging.

5.3 What Are the Main Factors that Affect Students’ Motivation in Junior Cycle Science in Ireland?

5.3.1 Goals

Performance goals tend to dominate students’ motivation in learning science. Results from this study show as early as 1st year, students tend to show the same level of agreement as students in 2nd and 3rd year that their “main goal in science class is to get a good grade”; 88.8% of 1st year students agreed to this, compared to 86.2% of 2nd year students and 90.6% of 3rd year students. What would enhance this research would be if there were data on students’ level of goal orientations in science, prior to attending post-primary school.

While it is possible to hold both mastery and performance goals for learning science, as explored in the literature review, students’ adoption of mastery goals in this study, was not as explicit or as great. On average, ~63% of all of the students surveyed agree that they “really like learning new things in science”, approximately a quarter less than those that indicated their strong performance goal orientation towards science. Similarly, very few of the open-ended responses made reference to students’ love of learning science for its own sake. Albeit, there were some, and they should be recognised. Typical comments relating to students’ mastery goal orientation in learning science include:

“I really love science”
“I love science, it’s fun and interesting!”

“I have from a young age always loved science and I am grateful you chose my class to help with your [research]”.

“I love science and enjoyed this questionnaire but most people in my class are the opposite”

“I don’t think that our grades in tests should be the key to getting a job but instead the knowledge that’s inside us.”

Certain phrases in these students’ comments (e.g. “most people in my class are the opposite”, “don’t think grades in tests should be the key to getting a job”) indicate that these students feel that they are somewhat of a minority. The last comment in particular is very powerful, conveying the message that the key to success in life is through academic performance and grades. Throughout this discussion chapter, and indeed that of the literature review, it has been found that the goal structures of the learning environment have a huge impact on the goals that students adopt. Students from the focus group who described having a caring teacher “who always wants [them] to do [their] best” still feel under pressure to perform in their Junior Certificate examination, and they feel that they “are expected to study all the time”. As alluded to in the literature review, school and societal cultures can influence students’ motivation both indirectly, by affecting their teachers’ instruction, as well as directly, by conveying effective messages beyond those delivered by the teacher in the classroom (Eccles et al. 1993; Kaplan and Maehr 1997; Boaler 2002). Schools have their traditions and legacies, their values, their ambitions and their accountability to parents and society at large. Little research has been conducted on how school types, particularly within the Irish context, affect students’ goal orientations and their motivation for science in general. There have been some studies carried out in Israel (Vedder-Weiss and Forus 2012), in America (Barker and Gump 1964) and in Canada (Niewswandt and Shanahan 2008) on how the goal structures in various schools affect students’ goal orientations, but further research is required in this area. It is not clear to what extent of students’ adoptions of certain goals depend on school size, location, gender and type to name but a few factors.

5.3.2 Learning Environment
The learning environment encompasses many factors which impact on students’ motivation in science class, some which have already been explored (e.g. goals) and some that are yet to be
explored (e.g. task value). It appears that the underlying and most influential factor is that of goals and the goals structures evident in the classroom; they dictate the schools’ practices, the teachers’ practices and ultimately the students’ practices.

In relation to the teaching methods employed in science class, students in this study articulated what they think is good science teaching practice:

“I think that when the teacher is showing us experiments and not doing it is pointless because the point of it is so we can visualise it and it is very important for kinaesthetic learners.”

“Science should be taught more ‘hands on’. We should use experiments to explain theory and study topics that are relevant to life and the world that are also relatable.”

“It would be better if we could interact more with science and it would be [more] fun if we did all fun experiments.”

“A new way of teaching this subject should be brought in. My classes and teacher are lifeless and boring.”

As will be described later under the Task Value heading, students appear more engaged and interested in science when participating in a meaningful activity, that is, something that is relevant to the students and is purposeful. What is interesting to point out here, is that many contemporary educationalists and researchers purpose that e-learning environments are one way to provide meaningful and engaging activities for students. Prensky (2002) pointed out in his study, ‘The motivation of gameplay: The real twenty-first century learning revolution’, that traditionally, many academics prefer to think of education as “work” as opposed to “fun” (p.5). Marc Prensky predicts however, that this will change as the generation raised on the engagement of games no longer accepts the historical but unnecessary separation of fun and learning.

This is not a recent observation or hypothesis to emerge. Don Norman remarked over 20 years ago that:

“When I watch children playing video games at home or in the arcades, I am impressed with the energy and enthusiasm they devote to the task…..Why can’t we get the same devotion to school lessons as people naturally apply to the things that interest them?”
It is suggested that the act of playing games in learning could be the key to motivating students in school. While game-players (video games) may have performance goal mindsets when playing games (e.g. beating the game and/or fellow players) Prensky (2002) argues that people who play games also find that the process of playing the game is engaging. The top two reasons why people play interactive games, he states, according to the Interactive Games Association, is because “people find it challenging and relaxing” (ibid, p.6). Hoffmann and Nadeslon (2010) reinforce these findings, when they claim that utilising new media applications that allow students to develop their digital literacy in the classroom, while encouraging characteristics of engaged play, might hold potential to increasing students’ motivation in science in school.

What did emerge from the data in this study was that teachers identified technology and new media as a great tool for students to communicate through. Some stated that students are “more computer-savvy and media-savvy than a lot of us [teachers] would be” and stated that “that’s the media that they associate with”. This is consistent with findings in the literature. De et al.’s (2005) study on American middle-school students found that the students were fluent in their virtual communication and expression, a skill that is undoubtedly required for 21st century living.

There is much debate surrounding the use of ICT and new media in science learning in schools. Some argue for the benefits as outlined above, however, others claim that the e-learning of today is only really useful for black-and-white (unambiguous) topics, not for the more essential problem-solving and interpersonal skills (Clive on Learning 2009). Others regard it as more effective and more efficient than traditional learning in schools, but that it cannot provide the skills of tomorrow on its own (ibid). One student in this study conveyed just how reliant some students are on technology, stating that she “doesn’t need science, [she has] Google!”. An interviewee teacher also mentioned this as a problem, explaining how she felt that “it’s almost like they’re [the students] losing the ability to think for themselves, like they’re being swayed or opinions are being formulated by what other people are saying about something rather than them forming an opinion for themselves”. The question that remains is what kind of learning is appropriate for the unknown future? (Barnet 2012)

**Teacher Qualities**
Aspects of student-teacher interactions seem to have a crucial impact on students’ academic outcomes and motivation to participate in class. The data collected from the student focus groups is indicative of the power that the student-teacher relationship has on students’ motivation in science. This was particularly evident for those that were classified as “low in motivation”. It was noted by the researcher that this was something that most of the students that were lower in motivation felt strongly about, as they were the first to speak and offer their opinion, when with all other questions they were not inclined to talk. One example of this is as follows in one of the 1st year student’s comment where she explains that “if she’s [the teacher] nice and not always giving out and stuff” she would consider her to be a good teacher. In a similar way, this student was the first person to share their feelings about what makes a bad science teacher, describing a bad teacher as “someone that’s always shouting and never like listens to ya and always gives ya loads of homework and stuff”.

Another student who was identified as low in motivation also appeared to feel strongly about the relationship they share with their teacher, explaining that a bad teacher, in their view, is somebody that “just....they just keep giving out to you”. When students felt that their teacher cared about them and had belief in their abilities, students felt that they wanted to keep working and live up to their teachers’ positive expectations. This was evident for students in the focus group that were highly motivated and for those that were low in motivation:

“\textit{They pushed…..they pushed you to do stuff. They just kept on to you to, it was just like they wanted you to do well so you just stayed going ahead and doing it}” (focus group participant: male, low motivation, 3rd year).

“\textit{Like I was missing for a few weeks and I came back, they [the rest of the class] had all their investigations done, and she stayed back and gave me extra notes and helped me...she always wants us to do our best}” (focus group participant: female, high motivation, 3rd year).

These findings corroborate those identified in the literature. It is documented that there are two main factors within the teacher-student relationship which are influential in determining students’ motivation in school: care and support (Noddings 1992; Turner and Meyer 1999; Wentzel and Battle 2001). As previously highlighted in the literature review chapter, teachers perceived as “caring” are reported to have qualities similar to those of an authoritative parent where they provide rules but avoid the restriction of autonomy (Noddings 1992). The
outcome of such relationships is that students respond with greater engagement and effort in class when they believe that their teachers care about them (Turner and Meyer 1999).

Teacher support is also a predictor of effort and the pursuit of social goals according to Wentzel (1997). Looking at this from a negative perspective, students who perceive their teachers to be cold and harsh are found to consistently display poor social behaviour, to have low social goals as well as achieving lower academically (Wentzel and Battle 2001). Smyth et al. (2004) found that for some students, especially working-class boys, they get caught up in a cycle of ‘acting up’ and ‘being given out to’ by teachers, especially from second year onwards. Students appear to become disaffected if they feel that the rules of the school, and their treatment by teachers, are unfair or arbitrary (ibid). Perhaps, the researcher suggests this is something that is particularly pertinent to second year students, as this is the year where teachers’ pedagogical approaches change, after the initial ‘honeymoon’ period of positive reinforcement of students in 1st year (Smyth et al. 2006). The prevalence of negative teacher-student interaction, that is, students being ‘given out to’ by teachers, increases considerably between first and second year (ibid).

Positive (accurate) reinforcement is the key to engaging, and re-engaging, students in science, according to the teachers who took part in this study.

5.3.3 Task Value

The value of science learning tasks certainly has an impact on students’ motivation in science. Two main themes have emerged from the data in relation to this: the meaningfulness of tasks, and the relevance of content.

The results of this study, and others (Abrahams 2009) show that the meaningfulness of science tasks seems to decline as students’ progress through the years in school. It appears that the novelty of using scientific equipment wears off after 1st year for students and that practical work moves away from being the “central appeal of science” (Palmer 2009) and becomes increasingly regarded by students as more of a “break” from “talk and chalk” or from “taking down notes”. One teacher in this study made reference to the mandatory practical work on the junior cycle science course, explaining that “the 30+ experiments are something of a misnomer. In truth most are practical activities with fully predictable outcomes. The coursework B investigations have a lot of merit but are usually well beyond the capabilities of the students without considerable help (teachers)”. Students themselves acknowledge this about the mandatory experiments on the science course, where one student
explained that although she “still like[s] science... [she’s] not that pushed towards the experiments, because [they] do a lot...”. She further describes how she’s “not as excited on going on doing them 'cause [she] know[s] like the how you do it”. Her comment implies that really there is no experimentation involved if you already know how to do it and what to expect.

From a different perspective however, many student participants from the focus groups suggested that they enjoy doing experiments where they could “get away from the desk” and do things “outside”, in a meaningful context. Even students’ lack of interest in physics appeared to be overcome when students carried out a “real” experiment using magnets and keys. One student stated:

“I liked the magnets in physics last time......Well we did like experiments with like say you get your keys and you just put the magnet on and see if it’s magnetic or not......All of our class kind of seem to know that better than all of the other topics that we’ve done”.

The majority of all of the student respondents, both from phase one and phase two, and in particular this group of 1st year students as referred to in the quotation, displayed a similar level of distaste and disdain for the physics aspects of the science course. Meaningful and interesting tasks however, can overcome students’ lack of interest in a topic, as implied here by this students’ comment. This corroborates Swarat et al.’s (2012) findings which revealed that, when judging the interestingness of an instructional episode, students focused primarily on the form of activity rather than the content topic.

Furthermore, it appears that there is quite a gap between the junior cycle science syllabus as intended in theory, and how it has been implemented in reality. In this study, as in many others, there appears to be a considerable lack of inquiry in the teaching of junior cycle science, where the majority of students surveyed (80.5%), reported that they spend most, or all, of class time taking down notes rather than experimenting “to test out [their] ideas on a science problem”.

The lack of inquiry is particularly evident in the practical work that is undertaken in science class. The “30+ experiments” that are on the Junior Certificate science course were described by one teacher as “practical activities with fully predictable outcomes”. The other practical elements of the science syllabus are the Coursework B Investigations, which have caused
“significant problems” since their introduction into the science syllabus in 2006 (Broggy
2010). These “problems” include:

- Ability of students – “one student does the investigation and the weak students just
  copy it down”.
- Unfair assessment – “green booklet cannot examine a skill perfected; it only tests the
  students’ ability to write and present information neatly”.
- Extent of the workload involved – “Coursework B is a test of the teacher, not the
  student”.
- Lack of resources.

(Higgins 2009)

It seems that the training and Continuing Professional Development (CPD) for science
teachers that was envisaged by the curriculum developers has not been put into practice. The
report published by the Department of Education and Science on teachers’ views of the
revised Junior Certificate science syllabus illustrated that the “practical and coursework
elements” of the syllabus were the most common topic that teachers wished to see addressed
in CPD workshops (Eivers et al. 2006, p.8). It was stated in the report that “although many of
the suggestions in the category were quite vague, the frequency with which Coursework B
was mentioned suggests an information gap that has not been filled by ICD [In-Career
Development]” (ibid, p.8). Also, as a result of the lack training for teachers, is that the
mandatory experiments in Coursework A are carried out in the traditional manner, with no
evidence of the use of inquiry, as outlined above.

Interesting times lie ahead in terms of science education in Ireland with the impending
implementation of the new junior cycle science curriculum across all post-primary schools in
September 2016. Both the new junior and senior cycle science frameworks will place an even
greater emphasis on inquiry than the revised science syllabus of 2003. This ultimately has the
potential to foster students’ sense of curiosity, relevance and awe in science in school, as well
as the possibility of providing adolescent students autonomy in their learning. However, it is
feared that the new proposals will make little difference to the way science is taught in
second-level schools. One of the main attributing factors for this, it is suggested, and as
experienced with the last reform, would be in the lack of CPD provided to science teachers.
To date, there have been no CPD programmes or courses provided to second-level science

162
teachers to help them in their approach of introducing and teaching the new junior cycle science course.

In addition to this, it certainly must be noted that “implementation of inquiry can be difficult as the vast majority of teachers have been taught themselves through more traditional direct transmission approaches and hence, may find it difficult to convert to a teaching approach they would never have used nor experienced before” (Barron et al. 2012, p.39). Therefore, without adequate training for teachers in inquiry-based teaching approaches, students will be unable to fully develop their cognitive skills that foster their investigation, imagination, and creativity, and ultimately, will not reap the potential enjoyment of studying science in school, particularly under the new junior cycle science framework.

With that considered, it is still important to note that the content of the topic can influence students’ motivation to study science or learn about it. Particularly influential is whether or not the content is relevant to students’ lives. The majority of both teachers’ and students’ reasons for why students tend to prefer biology as a subject is because it is more relatable, whereas chemistry and physics deal with, what appears to be, much more “abstract and difficult concepts”. Many of the teachers asserted that “we need to make the chemistry and physics more relevant to teenagers”. Students want to learn about more recent scientific advances such as “cancers, space and nutrition”.

Evidence of the powerful effects of making science content relevant to students can be found in context-based projects such as Salters in the UK (Bennett and Luben 2006), Chemie im Kontext in Germany (Parchmann et al. 2006), and the Standard Grade physics course in Scotland (Reid and Skryabina 2002), which is credited for making physics the most popular of the three main science subjects in Scotland. Usually physics is third in popularity (as it is in Ireland).

The researcher suggests that relevance is one of two things that could be key to keeping second year “students on board” with science (the other factor relating to autonomy) and avoiding that “drift” that many teachers describe as happening to second year students. Interestingly, only one small scale study has been conducted in Ireland on the benefits of implementing context-based or STS (Science Technology and Society) approaches on the teaching of science in second-level schools (Smith and Matthews 2000). The results of this study clearly indicate that the STS approach to science teaching seems to be more favoured by Irish students than the traditional approach. Students in the study in the STS group
expressed the view that science teachers in Transition Year\textsuperscript{47} are "very interested in the students, they discuss things that affect our lives" \textit{(ibid, p. 114)}. Furthermore, Smith and Matthews (2000) reported that the STS approach allowed more time to be given to students’ inquiries rather than textbook formulated questions. Teachers using the STS approach also helped students in researching answers to their own questions and interests, thereby allowing students to relate science to their daily lives. As a result of this, it was found that the number of students in the STS group wishing to opt for physics for their Leaving Certificate doubled after the context-based instruction.

Clearly, there is a need for more research in this area in Ireland. This will be highlighted in the ‘Future Research’ section in the concluding chapter.

5.3.4 Family Background

Despite the fact that no information was collected in relation to students’ family background from the questionnaires or from the focus groups, teachers constantly mentioned it as one of the key factors affecting students’ motivation in science, both in the interviews and in the additional comments section of the teacher questionnaires. “Social background” was described as having “a lot to do with” students’ motivation in science, where either “\textit{parents can sometimes pass on a very negative attitude that science is very difficult and will never be understood}” or where “most students are motivated because they come from stable family units where huge emphasis is placed on education”.

Much research has been carried out on the effects of parental influence on students’ motivation, where most have found that positive attitudes to science are strongly positively related to having a father and mother who support science (Breakwell and Beardsell 1992). On the other hand, parental pressure was found to be a negative predictor of motivation of science achievement—especially for girls in Koutsoulis and Campbell’s (2001) study of Greek students in Cyprus.

Investigating the findings from the PISA 2006 study, in which science was the main focus, it was revealed that poor performance in school does not automatically follow from a disadvantaged home background. However, it was found that home background, measured on an index summarising each student’s economic, social and cultural status, remains one of the

\textsuperscript{47}Transition Year is an optional year in Ireland between junior and senior cycle where there is no set curriculum. It gives students the opportunity to try out different subjects and to gain work experience before they make their decisions about what subjects they wish to pursue for further study.
most powerful factors influencing performance. On average across the OECD countries it explained 14% of the student performance variation in science (OECD 2007).

5.3.5 Gender
The final factor that will be explored here, as it has cropped up in almost every facet of this project, is that of gender. It is worthwhile to consider how the variable of gender can, and does, influence students’ motivation in science.

In examining how male and female students view science in school, it appears that there are some significant differences, and also, some interesting non-significant differences, relating to how difficult science is perceived to be, how goal orientations are affected by gender and how interesting certain aspects of science are, according to male and female science students.

Firstly, there proved to be no significant difference among male and female’s responses to the Likert statement ‘science in school is interesting’ (p=0.421). Furthermore, there were no significant gender differences in students’ views on how difficult they perceive science to be, with both males and females finding it equally difficult (p=0.063). What did appear to differ was students’ sense of science self-concept.

Following on from this, it is widely considered that girls are more academically focused in post-primary school than their male counterparts (Epstein 1998; Smyth 2010). They tend to employ more effective learning strategies and expend greater effort on their school work. On the contrary, they tend to experience lower levels of self-concept (Eisenberg et al. 1996; Eccles et al. 1998; OECD 2007). In this study, it was found that males have a significantly higher science self-concept than females (p=0.133), reiterating much of the research carried out in this area (Bandura 1986; Brown and Gilligan 1992; Orenstein 1994; Pipher 1994; Eccles et al. 1998; DeBacker and Nelson 2000; OECD 2007).

Both males and females conveyed similar levels of performance goal orientation in this study, where they equally agreed that their “main goal in science class is to get a good grade” (p=0.133). One aspect of performance goal orientation where females differed very significantly from males, was in their greater desire to “show family, friends and teacher that [they] are able to do well” (p<0.001). It may be argued that female students are trying to compensate for their own feelings of low self-concept and confidence in science, by endeavouring to portray to others that they can do well.
As stated previously, females tend to perform better academically in post-primary school. What is of interest to note, is that once boys do go to college or university, their academic performance begins to match that of girls (Devine cited in McGuire 2015). It has also been stated that this is where males start taking over, ultimately dominating the senior ranks of academia (*ibid*). The researcher suggests that it is males’ later development into adolescence that may be influential to males’ later academic development. This is an area of further research that could extend and enhance this research project.

With regards interest in and/or the intention of studying particular science subjects for the Leaving Certificate, male and female students differed greatly here. Male students showed a much higher interest in the physical sciences compared to females (p<0.001 for physics, p=0.017 for chemistry), whereas females conveyed that they are more concerned with studying biology (p<0.001). Reinforcement of this point comes in the form of students’ comments from the focus groups:

“I hate physics. It’s really hard. Because I’m not very good at maths either then so it’s quite hard to do like” (focus group participant: female, moderate motivation, 2nd year).

“I think I only like biology, because that’s like the only thing I get…. The rest I don’t” (focus group participant: female, low in motivation, 3rd year).

These findings are consistent with the literature.

A final point to consider here, which is not entirely related to gender, is the type or calibre of students who choose to study these science subjects for their Leaving Certificate examination. Students that choose to study biology for their Leaving Certificate in Ireland tend to be a broad range of students of mixed ability levels. Physics and chemistry, on the other hand, usually attract a lower number of students, but students of high ability who usually study other “difficult” subjects such as honours level mathematics. Data from the State Examinations Commission reveal that although biology is by far the most liked science subject, it is the one in which students perform least well, as outlined in the literature review48.

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48 See literature review under heading 3.4 ‘Are students motivated to study science in school?’ and sub-heading ‘Student achievement in science’.
5.4 Are Irish Students Motivated to Study Junior Cycle Science in School?

Are Irish students motivated to study junior cycle science in school? It is difficult to say.

On reviewing the motivation literature in attempts to gain a clear picture of how all the motivation variables fit together in one coherent, map-like structure, and moreso, on carrying out this research project, the researcher has come to think that perhaps the first research question of this project is an inappropriate one.

Despite much of the literature explaining that motivation is a complex, multi-faceted, situation-specific construct, the majority of research studies that have been carried out into students’ motivation in science still try to generalise it, and try to quantify it. It took the researcher the journey of wading through the literature, carrying out the teacher interviews and student focus groups and immersing herself in the data to realise that perhaps this is the wrong approach for studying motivation in science. Many students are motivated to study science in a typical sense, that is, they appear diligent, hard working, they achieve and they are interested in learning science for the sake of learning science. Many other students are also motivated, motivated to “show others that they are able to do well in science”, motivated “to study science harder” because they want to become a mechanic, or motivated to “keep going” because their teacher believes in them and their ability.

It should be pointed out that the researcher felt that it was the qualitative data that provided the most insight and clarity into the complex construct of students’ motivation in science, particularly data from the students’ perspectives. That qualitative data shed light on areas that are often overlooked or unnoticed. An example of this is that students who were considered as unmotivated or low in motivation, as identified by their teachers for the focus groups, actually lit up when describing certain aspects of science class, displaying high levels of motivation. One male 3rd year student, who was labelled as highly unmotivated described how he really enjoyed learning about the blood systems in science. Both of his parents are nurses and he figured that the interest just “transferred through” to him. Students are aware, they are intuitive, they understand where they are in the pecking order in the classroom. Because they are considered as low in motivation, and often low in ability, they start to believe this, despite their motivation and interest in certain aspects of science in school.

In a second example of this, a girl in 2nd year, also considered highly unmotivated described the respect she had for her science teacher because she was able to “have a laugh with you in
class”, she showed that she trusted her students with the experiments, and that she would help her until she understood. This conveys to the student that it is just as important for the teacher for her to understand a science concept as the most highly motivated or most academic student in the class; “she believes in you so you just keep going”. However, if a teacher just rushes through things and doesn’t care if their students comprehend them or not, the “students are going to stop caring also”.

Perhaps what motivation researchers are trying to do is to measure all students on one particular scale, suitable in assessing some students’ motivation in science but not others. The cartoon in Figure 5.1 illustrates this point in relation to assessment.

![Figure 5.1: Cartoon depicting the education system’s approach to assessment (source: Marquette University 2012).](image)

5.5 Conclusion

In conclusion, students’ motivation orientations and levels do vary as they progress through the junior cycle. 1st year students initially convey great enthusiasm for science and for doing science experiments, despite how difficult they find the subject. In 2nd year, there appears to be a great shift in students’ attitudes towards science, with teachers believing that students tend to “drift” in this year and become unmotivated due to the lack of “focus” of an examination and because of their increased interest in social relationships. 2nd year students themselves reported being quite interested in science in 2nd year but become disillusioned with the way science is taught in school. They seek greater autonomy over their own learning
and want to partake in meaningful science activities. 3rd year students’ motivation on the other hand, is largely affected by the impending Junior Certificate examination at the end of the year.

In terms of the factors that affect students’ motivation in junior cycle science, well, there are many. The predominant factors to emerge from this study include goals and goal structures, teaching practices, meaningful and relevant science tasks and teacher-student relationship (which in turn has a major impact on students’ self-concept and esteem). Family background was also highlighted as an important factor affecting students’ motivations by some of the teachers in the study, but the data is not sufficient for the researcher to say this with confidence.

What is clear is that the teacher can play a major role in students’ motivation for science. Although no one person can claim sole responsibility for motivating another person, teachers can make learning attractive and stimulating, provide opportunities and incentives for learning (such as developing students’ sense of autonomy), allow for their students’ development and match their interests with teaching content (Christophel 1990).

Below is a list of the implications of this research project for those interested in addressing students’ motivation in school science:

- **Self-concept** – This has been identified by both the teachers and the students who participated in this study as the key factor in reengaging disengaged students in science. It is important for educators to provide positive, yet accurate, feedback to students in order to build their sense of science self-concept.

- **Performance goal orientations** – This orientation is important for students motivation in science and it is one in which students’ motivations are mostly orientated. Care should be taken by teachers about the messages they convey to their students regarding the goal structure of their classroom. 1st year science students experience great differences in the goal structure from their primary school science class to their post-primary school one, with a major increase in emphasis on performance. *Assessment for learning* rather than *assessment of learning* is recommended where possible. Particular care should also be taken in the goal structures of 3rd year science classes, where many students feel under great pressure because of the impending state examination, the Junior Certificate examination.
• **Inquiry** – The form of an activity can overcome a student’s lack of interest in the content of an activity. Central to the appeal of science is its practical element; however, with students’ liking of practical work moving from an absolute liking to a relative liking of science as they progress through school, it is important for teachers to develop a sense of inquiry in their science teaching. This will enable students to develop their skills of investigation, imagination and creativity and will ultimately increase their mastery goal orientation.

• **Relevance** – This has been discovered to be an influential factor in students’ interest in, and motivation to study science, particularly to study certain science subjects. More relevance has to be placed on science in school, by teachers highlighting its applications in everyday life as much as possible. Particular attention should be placed on illustrating the everyday phenomena of physics and chemistry, where their relevance to everyday life is not always as explicit for students. The limitations of this study, the implications for practice and areas of future research will all be outlined in the following and final chapter.
Chapter 6: Conclusions

6.1 Introduction

The aims of this research project were outlined in chapter 1:

- To investigate how motivated Irish post-primary students are to study science at junior cycle level.
- To explore the factors that affect students’ motivation in science at junior cycle level in Ireland.

The research questions guiding this research project have been addressed and discussed in chapter 5. The findings from this research project may contribute to the improvement of teaching and learning of science in Ireland by providing greater insight into the facets of students’ motivation in education, into the problems associated with this, and also into the possible solutions that may help to create and maintain curiosity amongst science students.

The main findings of this research project are outlined in Figure 6.1 below. The limitations of this study are addressed in section 6.2 and the recommended future work for this project is explored in section 6.3. To conclude, the author wishes to reflect on her research journey through this project, and what she would do differently if she were to conduct the research again.
6.2 Limitations of the Study

Overall the results obtained from this research project were sufficient to answer the research questions, with perhaps, exception to the first question (as referred to in the discussion). There are however, a number of factors which limited the scope of the results of this study and they are as follows:

1. Motivation questionnaire – the main limitation of this research project lies in the quantitative instruments used to assess students’ motivation in science. It is very difficult to develop a questionnaire that is reliable and valid when assessing the
complex issue of motivation, as outlined in the literature review. Many of the scales that have been used in this study have been developed based on other studies. The original scales from validated questionnaires were not appropriate for use in this study and hence had to be adapted. This affects the reliability of the instrument but it also does not allow for direct comparison of results among studies.

2. Not all motivational variables were explored by the researcher in detail. Rather, the researcher decided to exclude particular bodies of work that centred on concepts that the researcher viewed as wide ranging in scope.

3. All aspects of the qualitative phase of the research project (i.e. 3 teacher interviews and 3 student focus groups) were carried in one large co-educational school. As all participants were from the same environment, one could argue that they all have similar views. In order to really use maximum variation sampling, schools of different type, size, student intake and location should have been sampled.

4. Sample of students and teachers involved – the students and teachers that participated in this research project ultimately were the ones in which were interested in this topic or in partaking in research projects. Such a school/teacher/student may have different opinions or different motivations than a school/teacher/student who rarely, if ever, engage in research. This variation may be reflected in their responses.

6.3 Directions for Future Work

Some of the findings in this research project are both interesting and worrying, and hence merit further investigation and research. The immediate issues to be addressed are outlined here:

- Motivational literature is vast and confusing, encompassing literature in the education, psychological and even neurological fields. Comprehensive literature reviews need to be carried out in order to provide a clear map of motivation and its variables for each field of study. There is too much literature on motivation, all with different terms and ideologies based on very similar concepts. Work needs to be done to update and clarify existing research.

- A review of existing instruments used to assess students’ motivation in junior and senior cycle science also needs to be undertaken. This needs to be carried out in order to prevent more unreliable and invalid instruments being developed. It is also worth being able to compare data from one study to another in order to provide a clearer
picture of how and why students are/are not motivated to study science in school across various countries and ethnic groups.

- Research on teaching methods employed by Irish post-primary school teachers is worth pursuing. Questions that the researcher is interested in answering, as they would be of value to this research project are: ‘do the interactions between students and science teachers differ significantly as students progress through the junior cycle? If so, in what way?; are students given the opportunity for more autonomy in their learning of science as they progress through the junior cycle? (this is something which research has shown to be something that students desire going through adolescence); what are the benefits, if any, of didactic and ‘teach-to-the test’ teaching approaches?’

- More work needs to be carried out on the characteristics of students who do/do not participate in the physical sciences; why do these students make the choice to study/not to study the physical sciences in Ireland?

- It would be worthwhile to gain insight into primary school students’ goal orientations. It would aid in understanding more about students’ motivational orientations allowing for deeper investigation into the effect of the transition from primary into post-primary school, and also into students’ progression in post-primary school.

- An investigation into school-wide characteristics and how they impact on students’ motivation would complement this research project. Questions such as the following would be worth pursuing:
  - How does school culture in Ireland impact on teaching practices and teachers’ emphases?
  - Which has the greatest effect in students’ motivation in science: parental influence or school culture?
  - Does single-sex schooling yield academic and/or motivational advantages for male and/or female students?

- Numerous inquiry-based research projects have been carried out in Ireland over the past number of years (e.g. TEMI, ESTABLISH, PROFILES, Fibonacci, CHREACT etc.) but there has been no formal communication or collaboration between these projects. What would be of great value to this project, and certainly to others, would be to analyse the findings of all of these works and investigate what impact have they had on science education in Ireland. Does inquiry improve elements of students’ motivation in science?
Finally, what is emerging as an interesting finding from this project is that males and females differ significantly in their motivation orientations towards science in school. An investigation into male and females’ adolescent development would enhance this research. What is curious is how adolescent development affects male and females’ academic development, and in turn, their motivation to study science in school. Previous research has shown that males start to match the academic performance of their female counterparts once they go to college; why is this the case?

6.4 Personal Reflection

The author began this research project in 2013, straight after graduating from her undergraduate degree, Bachelor of Science in Education (Physical Sciences), from the University of Limerick. The initial intention of the research project was to explore the factors that affect students’ motivation in science, to discover where and why students’ motivation in science starts to decline, and to investigate whether or not a context-based teaching intervention programme could improve students’ motivation in science. It is clear that this is not the path that was followed for this research project. It was not followed for a number of reasons. Firstly, this initial plan assumed that it would be possible to clearly identify all of the factors that affect students’ motivation in science. Secondly, it was presumptuous of the author to think that a context-based teaching approach would be an appropriate intervention programme before any analysis of data was carried out. Finally, the difficulty of measuring students’ motivation was not taken into consideration. Rather, the course of this research project changed and developed the more reading and background research that the author undertook.

What influenced the author’s initial plan and interest in this project was her experience on teaching practice, her work on a Final Year Research Project (exploring the benefits associated with participating in science outreach), her involvement in the EU-FP7 inquiry-based TEMI (Teaching Enquiry with Mysteries Incorporated) project and also her participation in running Science Magic Shows (throughout Munster with the aim of enthusing junior cycle students in the physical sciences). From all of these experiences it was clear to the author that students’ interest and motivation in science seemed to be declining with increasing time in school and that the majority of teaching carried out in post-primary school science appeared to be didactic in nature. Hence, the author believed that it was the teaching of science that was key to motivating students.
Like many others, the author believed, in the beginning, that motivation was a unitary phenomenon, where one was either academically motivated to study science or not, or that interest and motivation were synonymous. She soon came to learn that this was certainly not the case. A wide range of constructs, theories and variables underpin the concept of motivation. In fact, it proved very difficult for the author to navigate and understand the vast literature of motivation and motivation in education. Most works on motivation deal with very specific aspects or facets of motivation but do not provide a clear picture of how each piece fits into the overall jigsaw of motivation.

A further obstacle that the author encountered in comprehending the literature was that much of the literature based on students’ motivation in science education was vague and often use the term ‘motivation’ interchangeably with ‘interest’ and ‘attitude’. Many of the main research reports in science education (such as ROSE, PISA, TIMMS) are of very little value to the field of students’ motivation in science, despite these reports claiming to have findings based on students’ motivational orientations.

The complex nature of motivation led to difficulty in identifying a suitable method for measuring students’ motivation in science, as outlined in the literature review and methodology chapters.

Despite all of these challenges, the author also learned a lot from undertaking this research project. She learned about the content behind the construct of motivation; she saw how powerful self-concept and self-efficacy can be in engaging and disengaging students in science while conducting the student focus groups and teacher interviews; she grew an appreciation for research and the process of carrying it out; and finally, she experienced the gap between research and practice. This last point may not seem like a positive, but the author feels that it is. When a researcher immerses themselves in the literature, it is very easy for them to get caught up in theories and frameworks surrounding the topic, and only believe what is published in a peer-reviewed book or journal article. The researcher can often forget or exclude the practical side of what it is that one is researching, what they believe in terms of their experiences and anecdotal accounts. By carrying out qualitative research, for this project, and by being a member of the TEMI team in Ireland (where the TEMI workshops acted as an extended forum where the author could converse and discuss inquiry and motivational-based issues with experienced science teachers), the author believes that these experiences enabled
her to connect the personal aspect of research with existing literature and theories, making it more real, grounded and insightful.

The author now wishes to explore aspects of the research that she would do differently, if she were to do the research again.

The author would have spent more time understanding the literature before deciding on research questions (the first research question of this project, in particular, would be altered) and the methods used to answer these questions. As the qualitative part of this research project yielded such interesting results, more emphasis would have been placed on this aspect of the research project. The qualitative sample would have been expanded to include different school types to investigate whether or not single-sex schooling influenced aspects of students’ motivation in science, for example. Furthermore, classroom observations would have been conducted in mixed ability classes to explore the differences between high, low and moderately motivated students in science class.


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193


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List of Appendices

Appendix 1: Teacher Questionnaire .................................................................................................... 208
Appendix 2: Student Questionnaire .................................................................................................... 216
Appendix 3a: Ethical Documentation ................................................................................................. 221
Part 1: Quantitative Study ............................................................................................................... 221
   Faculty of Science & Engineering Research Ethics Committee Full Application Form ............ 221
   Student Information Sheet ............................................................................................................. 231
   Student Consent Form ................................................................................................................. 233
   Parent/Guardian Information Sheet ............................................................................................. 234
   Parent/Guardian Consent Form .................................................................................................... 236
   School Principal Information Sheet ............................................................................................. 237
   Principal Consent Form ............................................................................................................... 239
   Teacher Information Sheet ......................................................................................................... 240
   Teacher Consent Form ............................................................................................................... 242
   Student Questionnaire .............................................................................................................. 243
   Teacher Questionnaire .............................................................................................................. 248
   Letter to Principal .................................................................................................................... 253
   Acceptance of the University of Limerick Child Protection Guidelines ....................................... 254
Appendix 3b: Ethical Documentation ................................................................................................. 255
Part 2: Qualitative Study ................................................................................................................. 255
   Faculty of Science & Engineering Research Ethics Committee Full Application Form ............ 255
   Letter to Principal .................................................................................................................... 266
   School Principal Information Sheet ............................................................................................. 267
   Teacher Information Sheet ......................................................................................................... 269
   Parent/Guardian Information Sheet ............................................................................................. 271
   Student Information Sheet ....................................................................................................... 273
   Principal Consent Form ........................................................................................................... 275
Appendix 1: Teacher Questionnaire

Students’ Attitudes and Motivation to Study Science
Teacher Questionnaire

The purpose of this questionnaire is to gain information about how you feel your Junior Cycle science students view science in school. It is part of a larger project investigating Irish students’ motivation in Junior Cycle science.

We would like to ask you to take part in this study by filling out the questionnaire based on your experience of teaching Junior Cycle science students in your school. The questionnaire should take approximately 10-15 minutes to complete. Your participation is voluntary and you may withdraw from the study at any time.

The questionnaire is divided into two parts:

• **Part 1** requires some general information about you and your school.

• **Part 2** relates to your views on Junior Cycle science students’ interest in science.

This questionnaire is anonymous so please **do not write your name** on the questionnaire on the next page. Please sign below if you would like to be involved in this study and tear off this sheet once signed in order to keep it separate from your responses and to protect your anonymity.

Thank you very much.

Signature ____________________________________________
Teacher Questionnaire

Part 1. Personal Information: Please place a tick in the appropriate boxes below.

1. Gender: Male ☐ Female ☐

2. How many years approx. have you been teaching Junior Cycle science?

3. What type of school do you teach in?

<table>
<thead>
<tr>
<th>All-girls</th>
<th>All-boys</th>
<th>Mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Secondary School</th>
<th>Community School</th>
<th>Comprehensive School</th>
<th>Vocational School</th>
<th>Other (please specify)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Small (0-299 pupils)</th>
<th>Medium (300-499 pupils)</th>
<th>Large (500+ pupils)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Urban</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Are Junior Cycle science classes in your school streamed or mixed-ability classes?

<table>
<thead>
<tr>
<th>Streamed</th>
<th>Mixed-ability</th>
<th>I don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

5. Which statement below best characterises parental expectations towards your school?

i. There is constant pressure from many parents who expect our school to set very high academic standards and to have our students achieve them. ☐

ii. Pressure on the school to achieve higher academic standards among students comes from a minority of parents. ☐

iii. Pressure from parents on the school to achieve higher academic standards among students is largely absent. ☐
6. Have you had any experience in the following type of projects/studies before?

<table>
<thead>
<tr>
<th>Project/Study</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inquiry-Based Science Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Context-Based Science Education</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If you answered yes to the question above please comment briefly on your experience.

7. How would you rate your level of confidence in teaching each of the following aspects of Junior Cycle science?

(Please place a tick in the appropriate box.)

<table>
<thead>
<tr>
<th>(Please place a tick in the appropriate box.)</th>
<th>Very Confident</th>
<th>Confident</th>
<th>OK</th>
<th>Not Confident</th>
<th>Not at all Confident</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemistry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. Which topic on the Junior Cycle science course do you find the least favourite to teach? Please choose one topic by ticking one box only.

**Biology**
- Food, digestion & associated body systems.
- The skeletal/muscular system, the senses & human reproduction.
- Animals, plants & microorganisms.

**Chemistry**
- Classification of substances.
- Air, oxygen, carbon dioxide & water.
- Atomic structure, reactions & compounds.

**Physics**
- Force and energy.
- Heat, light & sound.
- Magnetism, electricity & electronics.
9. Please explain why this is your least favourite topic to teach.

Part 2. Students’ Interest in Science:

1. Which topic on the Junior Cycle science course do you think is students’ least favourite topic to learn about? Please choose one topic by ticking one box only.

<table>
<thead>
<tr>
<th>Biology</th>
<th>Chemistry</th>
<th>Physics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food, digestion &amp; associated body systems.</td>
<td>Classification of substances.</td>
<td>Force and energy.</td>
</tr>
<tr>
<td>The skeletal/muscular system, the senses &amp; human reproduction.</td>
<td>Air, oxygen, carbon dioxide &amp; water.</td>
<td>Heat, light &amp; sound.</td>
</tr>
<tr>
<td>Animals, plants &amp; microorganisms.</td>
<td>Atomic structure, reactions &amp; compounds.</td>
<td>Magnetism, electricity &amp; electronics.</td>
</tr>
</tbody>
</table>
.Which of the following statements do you think best describes students’ interest in Junior Cycle science? Please choose one statement by ticking one box only.

Students’ interest in science…….

| Increases as they progress from 1st to 3rd year in school. |
| Remains the same as they progress from 1st to 3rd year in school. |
| Declines as they progress from 1st to 3rd year in school. |
| Declines between 1st and 2nd year but increases in 3rd year. |
| Increases between 1st and 2nd year but declines in 3rd year. |
| I do not agree with any of these statements. |

3. At what points do you think students are most interested and least interested in Junior Cycle science in school?

| Most interested (Tick one box only.) | Least interested (Tick one box only.) |
| First Year | Second Year | Third Year |
| Start of year | End of year | Start of year | End of year | Start of year | End of year |

4. Do not worry if you find that some of the questions below appear to be similar. This has been done intentionally. Please try to answer each question as honestly as possible and please respond to the following statements from the perspective of:

“I think that students’ interest in science can decline in school because…….”

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Unsure</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Please place a tick in the appropriate box for each statement.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Science is one of the most difficult subjects offered at Junior Cycle.</td>
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</tr>
<tr>
<td>2. Of the workload involved in designing, experimenting and writing-up the Coursework B investigations.</td>
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</tr>
<tr>
<td>3. Time in class is spent linking the</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
4. Students don’t understand the point of learning science in school.

5. Students find that science has lots of concepts that they cannot understand.

6. Students must spend a substantial amount of time in class taking down notes and writing up experiments.

7. Of the practical aspect to Junior Cycle science.

8. Students feel that they are not able to get a good grade in science no matter how hard they try.

9. Students have to do investigative work in science class before they get to look at the theory.

10. Students cannot see a link between what they learn in science class and their everyday lives.

“I think that students’ interest in science can decline in school because…….”

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Unsure</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Science classes are spent listening to the teacher explaining the science concepts.</td>
<td></td>
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</tr>
<tr>
<td>12. Students are not able to complete the Coursework B investigations by themselves.</td>
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</tr>
<tr>
<td>13. Students learn about science in their everyday life in school which they feel does not link to what they must know</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
for the exam.

14. Students have to think about science problems before the answer will be explained to them.

15. Students feel that they are not as good at science as they are at other school subjects.

16. Students find some aspects of the science course very challenging.

17. Of the large amount of content on the Junior Cycle science course.

18. There is no relation for students between what they learn in science class and what they learn in other subjects.

19. Students think science class should involve doing experiments all the time but in reality that does not happen as there is a lot of theory to get through.

“I think that students’ interest in science can decline in school because…….”

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Unsure</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Please place a tick in the appropriate box for each statement.)</td>
<td></td>
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</tr>
<tr>
<td>20. Students must carry out numerous science experiments as part of the science course.</td>
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</tr>
<tr>
<td>21. Discussions about science in the news take place in class which students feel is a waste of time.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. Are there any other factors that you feel contribute to a decline in students’ interest in science in school?

Please use the space below if you have any other comments that you would like to add about this questionnaire.

Thank you very much for completing this questionnaire!
Appendix 2: Student Questionnaire

Students’ Attitudes and Motivation to Study Science Questionnaire

This questionnaire will be used to gather information about your feelings on science in school. It is part of a big project that is examining Irish students’ motivation in Junior Cycle science. We would like to ask you to take part in this study by filling out the questionnaire based on your past year in school. The questionnaire should take 10-15 minutes to fill out.

You do not have to complete this questionnaire if you do not want to. Also, you can decide to stop filling out the questionnaire at any time if you wish. All of your answers and personal information will be kept strictly confidential. That means that nobody in or outside of your school will see your answers. Please do not write your name on the questionnaire on the next page.

The questionnaire is divided into 5 parts:

Part 1. Personal information about you and your school.
Part 2. Your feelings about science in school.
Part 3. What you do in your science classes.
Part 4. Your learning of science in school.
Part 5. Science and your future.

There are no right or wrong answers to this questionnaire. We just want you to answer each question as honestly as you can.

Please sign below if you would like to be involved in this study. Please tear off this sheet once signed and hand it up to make sure that your answers are kept separate and confidential.

Thank you very much.

Signature

_____________________________________________________________
Student Questionnaire

Please read each question carefully and place a tick in the box that is most true for you.

Part 1. About You and Your School:

1. Gender: Male ☐ Female ☐

2. Age: 

3. Year in school: 1st ☐ 2nd ☐ 3rd ☐

4. What type of school do you go to?
   All-girls ☐ All-boys ☐ Mixed ☐

Part 2. Your Feelings about School:

Please answer the questions below based on your past year in school. Do not worry if you find that some of the questions seem the same. This has been done on purpose. Just try to answer each question as honestly as you can.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Unsure</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Please place a tick in the appropriate box for each statement)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Science is a difficult subject.</td>
<td></td>
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</tr>
<tr>
<td>2. Science in school is interesting.</td>
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<td></td>
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</tr>
<tr>
<td>3. I would like to have as much science as possible at school.</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Science classes bore me.</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>5. What I learn in science classes helps me to make sense of things in my everyday life.</td>
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</tr>
<tr>
<td>6. I would enjoy school more if there were no science classes.</td>
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<tr>
<td>7. I look forward to science class.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I can easily understand new ideas in science.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. I don’t understand the point of learning science in school.</td>
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</tr>
<tr>
<td>10. School science has made me wonder about the things we cannot explain yet.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Science in school is easy for me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Part 3. What You Do in Your Science Classes:

How often, **over the past year**, have you done the following things in your science classes?

<table>
<thead>
<tr>
<th>Class Activities</th>
<th>All classes</th>
<th>Most classes</th>
<th>Some classes</th>
<th>Hardly any classes</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Please place a tick in the appropriate box for each activity)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. I link what I learn about science to my everyday life.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2. I hear about the types of jobs that use science.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. I copy notes the teacher gives me into my copy book.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. I explain my own ideas about each new science topic to the teacher.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I listen or get involved in discussions in class about science in the news.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. I watch the teacher do experiments instead of doing them myself.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. I write my experiments into my lab notebook.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I get the chance to do hands-on, investigating work <strong>before</strong> looking at the theory.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. I listen to the teacher explain science ideas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. I link what I learn in science to what I learn in other subjects.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. I think about a science problem <strong>before</strong> it is explained to me by the teacher.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. I do an experiment to test out my ideas on a science problem.</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Part 4. Your Learning of Science in School:

Again, do not worry if you find that some of the questions seem the same. This has been done on purpose. Just try to answer each question as honestly as possible and remember to base your answers on your **past year** in school.

<table>
<thead>
<tr>
<th>Statement (Please place a tick in the appropriate box for each statement)</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Unsure</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. My main goal in science class is to get a good grade.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. I will never be able to get an excellent grade in a science test no matter how hard I try.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. I really like science that is interesting even if it is difficult to learn.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>4. I feel good when I manage to understand a difficult science idea.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I don’t care if the other students in my class do better than me in science tests.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. If I do badly in a science test it is because I did not study hard enough.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. I believe that I can do very well in science tests if I put a lot of effort into studying it.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I want to do well in science class because it is important to show my family, friends and teacher that I am able to do well.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. I am not as good at science as most of the other students in my class.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. I don’t like learning science because I don’t think I will ever need it in my everyday life.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. I really like learning new things in science class.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. If I work hard enough I will be able to understand all of the science topics on the course.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. I find that science has lots of ideas that I can understand.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Part 5. Science and Your Future:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Unsure</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I would like to become a scientist.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. A job as a scientist would be too boring.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3. Science is important for helping us to understand the world.</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>4. When I grow up I would like to work with people who make discoveries in science.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I would not like to be a scientist because the work would be too hard.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Science has opened my eyes to new and exciting jobs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. I would like to study science subjects for my Leaving Cert.</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I think physics is an interesting part of science.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. I think biology is an interesting part of science.</td>
<td></td>
<td></td>
<td></td>
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<td>10. I think chemistry is an interesting part of science.</td>
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</table>

If there is anything else that you would like to say about the questions please write it down in the space below.

*Thank you very much for filling out this questionnaire!*
# Appendix 3a: Ethical Documentation

## Part 1: Quantitative Study

Faculty of Science & Engineering Research Ethics Committee Full Application Form

<table>
<thead>
<tr>
<th>1</th>
<th>Title of Research Project</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>An Investigation of Factors Affecting Student Motivation in Junior Science and the Development and Evaluation of Strategies to Improve Student Motivation in Science.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2</th>
<th>Period for which approval is sought</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>February 2014 – September 2016</td>
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<table>
<thead>
<tr>
<th>3</th>
<th>ProjectInvestigators</th>
</tr>
</thead>
<tbody>
<tr>
<td>3a</td>
<td>Principal Investigator (Supervisor)</td>
</tr>
<tr>
<td></td>
<td><strong>Name</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Department</strong></td>
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<tr>
<td></td>
<td><strong>Position</strong></td>
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<tr>
<td></td>
<td><strong>Qualifications</strong></td>
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<td></td>
<td><strong>Telephone Number</strong></td>
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<td></td>
<td><strong>e-mail address</strong></td>
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</table>

<table>
<thead>
<tr>
<th>3b</th>
<th>Other Investigators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name</strong></td>
<td><strong>Qualifications &amp; Affiliation</strong></td>
</tr>
<tr>
<td>Teresa Curtin</td>
<td>Co-Supervisor. PhD.</td>
</tr>
<tr>
<td>Beulah McManus</td>
<td>B. Sc. Education (physical)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4</th>
<th>Head of Department(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I have read through this application and am aware of the possible risks to subjects involved in this study. I hereby authorise the Principal Investigator named above to conduct this research project.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Name</strong></th>
<th><strong>Department</strong></th>
<th><strong>Date</strong></th>
<th><strong>Signature</strong></th>
</tr>
</thead>
</table>

### 5 Study Descriptors

*Please indicate the terms that apply to this research project*

<table>
<thead>
<tr>
<th>Category</th>
<th>Healthy Adults</th>
<th>Healthy Children (&lt; 18 yrs)</th>
<th>Patient Adults</th>
<th>Patient Children (&lt; 18 yrs)</th>
<th>‘Potentially Vulnerable’ Adults</th>
<th>‘Potentially Vulnerable’ Children</th>
<th>Physical Activity</th>
<th>Questionnaire/Interview</th>
<th>Medical Devices / Drugs</th>
<th>Video Recording/Photography</th>
<th>Food/Drink Supplementation</th>
<th>Collection of Personal Details</th>
<th>Measure Physical in Nature</th>
<th>Measure Psychological in Nature</th>
<th>Body Tissue Samples</th>
<th>Body Fluids Samples (e.g. blood)</th>
<th>Record Based</th>
</tr>
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<td>X</td>
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### 6 Project Design
Justification for Research Project (Include reference to published work)

The aim of this project is to address the problem of motivation in students studying science in the junior cycle. It has been found that young people entering secondary school generally have positive attitudes towards science, however, this declines most sharply between the ages of 11 and 14 (Bennett and Hogarth 2005). Of further concern is the considerable gap between the proportions of students studying the physical sciences and those studying biology. Approximately four times more students sat the 2013 Leaving Certificate Biology Examination compared to those that sat either the Physics or Chemistry Examination (SEC 2013). It is clear that there is a need, now more than ever, to inspire young people to study science at school, in order to develop the knowledge economy required for future growth and prosperity.

The focus in this project is on science education at Junior Certificate level. It is at this level that many students become disengaged and unmotivated in science, particularly the physical sciences, and do not continue with them into the senior cycle. There has been little systematic research on science teaching methods employed in Irish secondary schools but existing evidence points to the dominance of more didactic approaches (Gilleece et al 2009). The context-based (Bennett et al 2006) and inquiry-based (European Commission 2007) approaches offer a way of improving science teaching in Ireland, by enhancing students’ perceptions of the relevance of science and by getting students more involved in their own learning.

This project will evaluate the effectiveness of the context-based and inquiry-led approaches in Junior Certificate science in engaging and motivating students, and hence improving attitudes and understanding in science. It is hoped that this increased interest will be translated into a desire in students to study science subjects beyond the junior cycle.

References:


Hypotheses or questions to be answered
1. What are the factors that affect student motivation in Junior Certificate science from the perspective of both students and teachers?
2. Are the inquiry-based and the context-based teaching and learning approaches successful in capturing and retaining students’ interest and motivation in Junior Certificate science and if so, how?
6c Plan of Investigation

This investigation involves the administration of two questionnaires; a teacher questionnaire and a student questionnaire.

1. Sampling: “The cost of sampling an entire population to answer a specific question is prohibitive in terms of time, money and resources” (Lunsford & Lunsford, 1995). Therefore, it will be essential to select a subset of subjects which are representative of the target population (Lunsford & Lunsford, 1995). As the second-level school types in Munster provide a representative sample of all school-types in Ireland (Ryan & Childs, 2012), the questionnaires will be administered to 20 post primary schools in the Munster region. It is intended to employ a systematic stratified sampling approach to select the 20 post primary schools in which to administer the questionnaires.

2. Administration: The student questionnaires will be completed by willing participants in each junior cycle science class per second-level school. Science teachers in these schools will also be asked to complete a teacher questionnaire. Participation will be voluntary for all students and teachers. Consent forms and information sheets for principals, teachers, parents and students will be provided. Teachers may decide upon either submitting the questionnaires by email or by submitting a pen and paper version. Pupil questionnaires will be available in a paper and pen version only. All questionnaires will be anonymous and all data will only be used for the purpose of this study. All completed questionnaires will be stored safely with access only available to the investigators.

6d Research procedures

Pupil and Teacher Questionnaires:

The pupil questionnaires will be administered by the classroom teacher. All questionnaires (completed and uncompleted) will be collected by the class teacher.

Teachers will have the option of completing a pen and paper version of the questionnaire or by

6e Associated risks to subjects

None.

6g Statistical approach to be used and source of any statistical advice

Quantitative data analysis will be carried out using the IBM SPSS statistical software. The Statistical Consulting Unit in the University of Limerick will be consulted.

If necessary, qualitative analysis using a specific package such as NVIVO will also be used.

6h Location(s) of Project

The questionnaires will be given to and completed by the pupils and teachers in their science classes in their own schools.
7 Subjects

7a How will potential research participants be sourced and identified?
The potential secondary schools that will partake in this study will be randomly selected from the Munster subset using the online research tool, Research Randomizer (accessed via http://www.randomizer.org). Science teachers in these schools will be contacted by the researcher through a written letter. Information sheets regarding the research project will be provided to the

7b Will research participants be recruited via advertisement (poster, e-mail, letter)?

YES □ NO

If YES, please provide details below, or attach the recruitment advertisement if written.

See letter to school principal attached.

7c How many subjects will be recruited?

Male 2700  Female

Provide further information if necessary

3-4 science teachers per secondary school x 10 schools = 40 teachers
270 junior cycle science students per school x 20 schools = 5400
Estimated total = 5440 participants

7d What are the principal inclusion criteria? (Please justify)

Science teachers teaching science at Junior Certificate level.

Pupils studying Junior Certificate science.
7e  **What are the principal exclusion criteria?** *(Please justify)*
All others (non-Junior Certificate science teachers and pupils).

7f  **What is the expected duration of participation for each subject?**
Teacher questionnaire: 10-15 minutes
Student questionnaire: 10-15 minutes

7g  **What is the potential for pain, discomfort, embarrassment, changes to lifestyle for the research participants?**
None.

7h  **What arrangements have been made for subjects who might not adequately understand verbal explanations or written information in English?**
The researcher will use clear concise English language in the student questionnaire and will use diagrams such as smiley faces where appropriate.
The teachers may also contact the researcher if any questions about the questionnaires arise.

7i  **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)*

   Yes  X  No

   **If Yes**
   **Please state what these arrangements are:**
   If individual pupils do not wish to participate in the research, they do not need to complete the questionnaire. These pupils will be assigned a short science related activity (set by the class teacher) to complete in the classroom while the other pupils complete the questionnaire. This is necessary to prevent distraction for the participating pupils in the classroom.
   
   It is not compulsory for teachers to complete the questionnaire either.
7) Will subjects receive any payments or incentives, or reimbursement of expenses for taking part in this research project?

YES  [x]  NO

If YES, please provide details below, and indicate source of funding:

8  Confidentiality of collected data

8a  What measures will be put in place to ensure confidentiality of collected data?

Paper based data will be stored in a locked filing cabinet. Computer-based files will be password protected. The principal investigator and researchers will be the only people who will have access to this information.

The pupils’ and teachers’ names will not be recorded on the questionnaires. All questionnaires will be

8b  Where will data be stored, ie Room Number?

F2-106
Second Floor,
Foundation Building,
University of Limerick.

8c  Who will have custody and access to the data?

The principal investigator and the other researchers will be the only people with access to this data.

8d  Data to be stored for 7 years after publication: How do you propose to store the information?

Will the file/computer be password protected?

Explained above (8a).

Where will the information be stored (room number):
<table>
<thead>
<tr>
<th>9</th>
<th>Drugs or Medical Devices</th>
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</thead>
<tbody>
<tr>
<td>Are Drugs or Medical Devices to be used?</td>
<td>YES [ ] NO [x]</td>
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<tr>
<td>If YES please complete 9a to 9c</td>
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<tr>
<th>9a</th>
<th>Details of the Drugs or Devices (including name, strength, dosage, route of administration)</th>
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<td>N/A</td>
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<tr>
<th>9b</th>
<th>Details of Clinical Trial Certificate, Exemption Certificate or Product Licence (The Product Licence must cover the proposed use in the Project)</th>
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<th>9c</th>
<th>Details of any Risks (Both to subjects and staff; indicate current experience with the drug or device)</th>
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<td>N/A</td>
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<tr>
<th>10</th>
<th>Professional Indemnity</th>
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</thead>
<tbody>
<tr>
<td>Does this application conform to the University's professional indemnity policy?</td>
<td>YES [x] NO [ ]</td>
</tr>
<tr>
<td>If NO please indicate the professional indemnity arrangements in place for this application (attach policy if necessary):</td>
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</table>
Please note: failure to provide the necessary documentation will delay the consideration of the application. Please complete the checklist below:

**Documents**

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<thead>
<tr>
<th>Description</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant Information Sheet</td>
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<tr>
<td>Participant Consent Form</td>
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<tr>
<td>Parent/Guardian Information Sheet</td>
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<td>Parent/Guardian Consent Form</td>
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<td>School Principal Information Sheet</td>
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<tr>
<td>Teacher Information Sheet</td>
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<tr>
<td>Teacher Consent Form</td>
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<td>Questionnaire/Interview/Survey Questions</td>
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<tr>
<td>Recruitment Letters/Advertisements/Emails</td>
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<tr>
<td>Acceptance of UL Child Protection Form</td>
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*Please ensure any additional documents are included with this application. These should be attached as a single document and included in the e-mail submission.*

**12 Declaration**

The information in this application form is accurate to the best of my knowledge and belief, and I take full responsibility for it.
I undertake to abide by the ethical principles outlined in the Science & Engineering Research Ethics Committee guidelines.

If the research project is approved, I undertake to adhere to the study protocol without unagreed deviation, and to comply with any conditions sent out in the letter sent by the Science & Engineering Research Ethics Committee notifying me of this.

I undertake to inform the Science & Engineering Research Ethics Committee of any changes in the protocol, and to submit a Report Form upon completion of the research project.

<table>
<thead>
<tr>
<th>Name of Principal Investigator</th>
<th>Peter Childs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signature of Principal Investigator</td>
<td>(or Head of Department*)</td>
</tr>
<tr>
<td>Date</td>
<td></td>
</tr>
</tbody>
</table>

*Please note: where the Principal Investigator is not a permanent employee of the University of Limerick, the relevant Head of Department should sign this declaration.*

1. Once completed, this form along with a single document containing any additional documentation should be submitted electronically to the Faculty Office, Science & Engineering at SciEngEthics@ul.ie

2. In addition, 1 copy of the fully signed application and any attachments should be submitted to:
The Secretary,
Faculty of Science & Engineering Research Ethics Committee,
University of Limerick
Student Information Sheet

Title of Project: An Investigation of Factors Affecting Student Motivation in Junior Science and the Development and Evaluation of Strategies to Improve Student Motivation in Science.

Introduction:

I am a student studying at the University of Limerick. I am carrying out a research project as part of my PhD. in order to understand where and why students become uninterested in Junior Certificate science.

Background to the project:

The aim of this project is to tackle the problem of students’ decline in motivation in Junior Certificate science and to discover where and why students “switch-off”. Studies have found that young people enter secondary school with positive attitudes towards science. However, these studies have also shown that students lose these positive attitudes towards science between the ages of 11 and 14. The focus of my project is to investigate whether or not using different teaching approaches will help students to become more engaged and interested in science.

What do I have to do?

If you would like to take part in this study, all you have to do is fill out a short questionnaire based on your feelings towards science. This will take approximately 15 minutes.

Confidentiality:

You do not have to write your name on the questionnaire and therefore you will remain anonymous. You do not have to take part in this study and you can stop taking part in the project at any stage. There are no risks associated with this study.

If you have any questions, please contact the investigators and we will clarify any issues that you are concerned about.

Principal Investigator:
Peter E. Childs (061 202486) Peter.Childs@ul.ie

Investigators:

Beulah McManus Beulah.Mcmanus@ul.ie

Teresa Curtin Teresa.Curtin@ul.ie

If you wish to contact somebody that is independent of this project, you may contact: The Chair, Faculty of Science and Engineering Research Ethics Committee, University of Limerick, Limerick. Tel: 061 202802.

Thank you for taking the time to consider participating in this study.

Kind Regards,

____________________

Beulah McManus
Student Consent Form

Title of Project: An Investigation of Factors Affecting Student Motivation in Junior Science and the Development and Evaluation of Strategies to Improve Student Motivation in Science.

- I have read and understand the subject information sheet.
- I am fully aware of the procedures involved.
- I understand what the project is about and what the results obtained will be used for.
- I am aware that any personal information and results collected will remain confidential.
- I understand that my participation is voluntary and I am able to withdraw from the project at any stage.

Participant’s Signature: ___________________________ Date: ________________

Investigator’s Signature: ___________________________ Date: ________________
Parent/Guardian Information Sheet

Title of Project: An Investigation of Factors Affecting Student Motivation in Junior Science and the Development and Evaluation of Strategies to Improve Student Motivation in Science.

Introduction:

I am postgraduate student studying at the University of Limerick. I am carrying out a research project as part of my PhD. in order to gain a clear insight into the factors that affect student motivation in Junior Certificate science.

Background to the project:

This project aims to address the problem of students’ decline in motivation in Junior Certificate science and to discover where and why students “switch-off”. It has been found that young people entering secondary school generally have positive attitudes towards science. However, this declines most sharply between the ages of 11 and 14 (Bennett and Hogarth 2005). The focus of this research project is to evaluate the effectiveness of using context-based and inquiry-based approaches to motivate and reengage students in Junior Certificate science. Context-based teaching approaches use relevant contexts and everyday applications of science to grab students’ attention as the starting point for the development of scientific ideas (Bennett et al 2006). Inquiry-led teaching approaches are based on the investigation of questions, scenarios or problems and are guided by a facilitator. Both of these approaches enhance students’ perceptions of the relevance of science and provide students with the opportunity to become more involved in their own learning.

What does this study entail for your son/daughter?

The involvement of your son/daughter in this project will comprise of the completion of 10-15 minute questionnaire. The purpose of this questionnaire is to gain a clear insight into students’ motivation and attitudes towards science.

Confidentiality:
All collected information will be held in strict confidence. Your child’s identity will remain anonymous. Hence, their name will not be required for the questionnaire. Your son/daughter is under no obligation to participate in this study and they have the right to withdraw at any stage. There are no risks associated with this study.

Should you have any questions, please contact the investigators and we will clarify any issues that you are concerned about.

Principal Investigator:
Peter E. Childs (061 202486) Peter.Childs@ul.ie

Investigators:
Beulah McManus Beulah.Mcmanus@ul.ie
Teresa Curtin Teresa.Curtin@ul.ie

If you wish to contact somebody that is independent of this project, you may contact: The Chair, Faculty of Science and Engineering Research Ethics Committee, University of Limerick, Limerick. Tel: 061 202802.

Thank you for taking the time to consider participating in this study.

Kind Regards,

Beulah McManus
**Parent/Guardian Consent Form**

**Title of Project:** An Investigation of Factors Affecting Student Motivation in Junior Science and the Development and Evaluation of Strategies to Improve Student Motivation in Science.

- I have read and understand the subject information sheet.
- I am fully aware of the procedures involved.
- I understand what the project is about and what the results obtained will be used for.
- I am aware that any personal information and results collected will remain confidential.
- I understand that the student’s participation is voluntary and they are able to withdraw from the project at any stage.

Parent’s/Guardian’s Signature: ________________ Date: ______________

Investigator’s Signature: ________________________ Date: ______________
School Principal Information Sheet

**Title of Project:** An Investigation of Factors Affecting Student Motivation in Junior Science and the Development and Evaluation of Strategies to Improve Student Motivation in Science.

**Introduction:**

I am postgraduate student studying at the University of Limerick. I am carrying out a research project as part of my PhD. in order to gain a clear insight into the factors that affect student motivation in Junior Certificate science.

**Background to the project:**

This project aims to address the problem of students’ decline in motivation in Junior Certificate science and to discover where and why students “switch-off”. It has been found that young people entering secondary school generally have positive attitudes towards science. However, this declines most sharply between the ages of 11 and 14 (Bennett and Hogarth 2005). The focus of this research project is to evaluate the effectiveness of using context-based and inquiry-based approaches to motivate and reengage students in Junior Certificate science. Context-based teaching approaches use relevant contexts and everyday applications of science to grab students’ attention as the starting point for the development of scientific ideas (Bennett et al 2006). Inquiry-led teaching approaches are based on the investigation of questions, scenarios or problems and are usually guided by a facilitator, i.e. the teacher. Both of these approaches enhance students’ perceptions of the relevance of science and provide students with the opportunity to become more involved in their own learning.

**What does this study entail for your school?**

The involvement of the science teachers from your school in this project will entail the completion of a 10-15 minute questionnaire. The questionnaire relates to teachers’ experiences of teaching science to junior cycle science students.
The involvement of Junior Certificate science (1st-3rd year) students from your school in this project will also comprise of the completion of 10-15 minute questionnaire. The purpose of this questionnaire is to gain a clear insight into students’ motivation and attitudes towards science at the junior cycle level.

Confidentiality:

All collected information will be held in strict confidence. Your school’s identity and the identity of the science teachers and pupils will remain anonymous. Hence, names will not be required for the questionnaires. Students and teachers are under no obligation to participate in this study and they have the right to withdraw at any stage. There are no risks associated with this study.

Should you have any questions, please contact the investigators and we will clarify any issues that you are concerned about.

Principal Investigator:

Peter E. Childs (061 202486) Peter.Childs@ul.ie

Investigators:

Beulah McManus Beulah.Mcmanus@ul.ie

Teresa Curtin Teresa.Curtin@ul.ie

If you wish to contact somebody that is independent of this project, you may contact: The Chair, Faculty of Science and Engineering Research Ethics Committee, University of Limerick, Limerick. Tel: 061 202802.

Thank you for taking the time to consider participating in this study.

Kind Regards,

Beulah McManus
**Principal Consent Form**

**Title of Project:** An Investigation of Factors Affecting Student Motivation in Junior Science and the Development and Evaluation of Strategies to Improve Student Motivation in Science.

- I have read and understand the subject information sheet.
- I am fully aware of the procedures involved.
- I understand what the project is about and what the results obtained will be used for.
- I am aware that any personal information and results collected will remain confidential.
- I understand that all student and teacher participation is voluntary and that they are able to withdraw from the project at any stage.

Principal’s Signature: __________________________  Date: ______________

Investigator’s Signature: __________________________  Date: ______________
Teacher Information Sheet

Title of Project: An Investigation of Factors Affecting Student Motivation in Junior Science and the Development and Evaluation of Strategies to Improve Student Motivation in Science.

Introduction:

I am postgraduate student studying at the University of Limerick. I am carrying out a research project as part of my PhD. in order to gain a clear insight into the factors that affect student motivation in Junior Certificate science.

Background to the project:

This project aims to address the problem of students’ decline in motivation in Junior Certificate science and to discover where and why students “switch-off”. It has been found that young people entering secondary school generally have positive attitudes towards science. However, this declines most sharply between the ages of 11 and 14 (Bennett and Hogarth 2005). The focus of this research project is to evaluate the effectiveness of using context-based and inquiry-based approaches to motivate and reengage students in Junior Certificate science. Context-based teaching approaches use relevant contexts and everyday applications of science to grab students’ attention as the starting point for the development of scientific ideas (Bennett et al 2006). Inquiry-led teaching approaches are based on the investigation of questions, scenarios or problems and are usually guided by a facilitator, i.e. the teacher. Both of these approaches enhance students’ perceptions of the relevance of science and provide students with the opportunity to become more involved in their own learning.

What does this study entail?

If you wish to participate in this study, you will be required to fill out a 15 minute questionnaire based on your experiences of teaching science to Junior Certificate science students.

There are no risks associated with this study. Your name and identification will not be recorded on your questionnaire. All collected information will remain confidential, will be used only for the
purpose of this study and it will be stored safely with access only available to the investigators. You are under no obligation to participate in this study and you have the right to withdraw at any stage. Should you have any questions, please contact any of the investigators and we will clarify any issues that you are concerned about.

Principal Investigator:

Peter E. Childs (061 202486) Peter.Childs@ul.ie

Investigators:

Beulah McManus Beulah.Mcmanus@ul.ie

Teresa Curtin Teresa.Curtin@ul.ie

If you wish to contact somebody that is independent of this project, you may contact: The Chair, Faculty of Science and Engineering Research Ethics Committee, University of Limerick, Limerick. Tel: 061 202802.

Thank you for taking the time to consider your participation in this study.

Kind Regards,

__________________________

Beulah McManus
Teacher Consent Form

Title of Project: An Investigation of Factors Affecting Student Motivation in Junior Science and the Development and Evaluation of Strategies to Improve Student Motivation in Science.

- I have read and understand the subject information sheet.
- I am fully aware of the procedures involved.
- I understand what the project is about and what the results obtained will be used for.
- I am aware that any personal information and results collected will remain confidential.
- I understand that my participation is voluntary and I am able to withdraw from the project at any stage.

Participant’s Signature: ___________________________ Date: ________________

Investigator’s Signature: ___________________________ Date: ________________
Student Questionnaire

Instructions:

The purpose of this questionnaire is to gain information about how you feel your students view science in school. This questionnaire is anonymous so do not write your name on this questionnaire. Please answer the questions as honestly as possible and please place a tick ( ✓ ) where appropriate.

The questionnaire is divided into three parts:

• Part 1 requires some general information about you, the student.

• Part 2 addresses your feelings about science over your past year in school.

• Part 3 relates to the teaching methods used in your science classes over your past year in school.

Part 1 Personal Information:

1. Gender: Male □ Female □

2. Age: ____________________________

3. Year in school: 1st □ 2nd □ 3rd □

4. What type of school do you go to?

   All-girls □ All-boys □ Mixed □

5. What has been the grade that you have received most often in science over the past year in school? Choose one answer only.

   A (85-100%) □
   B (70-84%) □
   C (55-69%) □
   D (40-54%) □
   E (25-39%) □
   F (10-25%) □
   NG (0-9%) □
6. Which of the following is your favourite science subject? Please choose one answer.

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<thead>
<tr>
<th>Science Subject</th>
<th>Place a tick in one of the following boxes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td></td>
</tr>
<tr>
<td>Chemistry</td>
<td></td>
</tr>
<tr>
<td>Biology</td>
<td></td>
</tr>
<tr>
<td>I like them all equally</td>
<td></td>
</tr>
<tr>
<td>I do not like any of these science subjects</td>
<td></td>
</tr>
</tbody>
</table>

7. Which of the following is your least favourite science subject? Please choose one answer.

<table>
<thead>
<tr>
<th>Science Subject</th>
<th>Place a tick in one of the following boxes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td></td>
</tr>
<tr>
<td>Chemistry</td>
<td></td>
</tr>
<tr>
<td>Biology</td>
<td></td>
</tr>
<tr>
<td>I like them all equally</td>
<td></td>
</tr>
<tr>
<td>I do not like any of these science subjects</td>
<td></td>
</tr>
</tbody>
</table>

8. What is your least favourite topic/chapter that you have studied on the Junior Certificate science course?

________________________________________________________________________

9. Please give a reason why you chose this topic to be your least favourite.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

244
Part 2 Your Feelings About Science in School:

1. Which word best describes your feelings about studying science? Please base your answer on your study of science over the past year in school. Choose only one answer.

- Fun
- Challenging
- Hard
- Boring
- Interesting
- None of these

2. Please explain why you feel this way about studying science.

__________________________________________________________________________________________

3. What do you think about the following statements based on your study of science? For each of the statements, please tell me how much you agree or disagree with them.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Unsure</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>My main concern in science class is getting a good grade.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I really like science topics that make me interested even if they are</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>difficult to learn.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I want to do well in science class because it is important to show my</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>family, friends and teacher that I am able to do well.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The science I learn in school is more important than the grade I receive.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
I like to do better than other students in my class on science tests.

I am nervous about how I will do on science tests.

I believe that I can do extremely well in science if I put a lot of effort into studying it.

<table>
<thead>
<tr>
<th>Part 3 Teaching and Learning Science in School</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How often do you do the followings things in your science classes? For each of the class activities, please rate how often you do them by placing a tick in the appropriate box.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class Activities</th>
<th>In almost all classes</th>
<th>In most classes</th>
<th>In some classes</th>
<th>In hardly any classes</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>We relate what we are learning about science to our daily lives.</td>
<td>🤗</td>
<td>😐</td>
<td>😞</td>
<td>😞</td>
<td>😞</td>
</tr>
<tr>
<td>We talk about the types of jobs that use science.</td>
<td>🤗</td>
<td>😐</td>
<td>😞</td>
<td>😞</td>
<td>😞</td>
</tr>
<tr>
<td>We copy notes the teacher gives use into our copies.</td>
<td>🤗</td>
<td>😐</td>
<td>😞</td>
<td>😞</td>
<td>😞</td>
</tr>
<tr>
<td>We work in groups (two or more people) doing</td>
<td>🤗</td>
<td>😐</td>
<td>😞</td>
<td>😞</td>
<td>😞</td>
</tr>
</tbody>
</table>
science activities (eg. experiment work, discussions, project work, answering questions)

We have class discussions on science topics.

We watch the teacher do experiments.

We do practical work (eg. Little experiments, investigations, demonstrations) before the science theory is introduced.

2. In your opinion, what is the best way to learn science in school? Please write your answer in the space below. (Examples could include: learning off notes, discussing a topic in class, doing practical work, researching a project, writing out experiments etc.)

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

If you have any further comments on this questionnaire please use the space below.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

*Thank you very much for completing this questionnaire!*
Teacher Questionnaire

Instructions:

The purpose of this questionnaire is to gain information about how you feel your Junior Certificate science students view science in school. This questionnaire is anonymous. Please answer the questions as honestly as possible and please place a tick (✓) where appropriate.

The questionnaire is divided into three parts:

• Part 1 requires some general information about you, the teacher.
• Part 2 relates to the teaching methods you have employed over the past year (or most recent year) in teaching Junior Certificate science.
• Part 3 addresses your thoughts on how your current (or most recent) junior cycle students feel about science in school.

Part 1 Personal Information:

1. Gender: Male [ ] Female [ ]

3. How many years approx. have you been teaching Junior Certificate science? ______________

4. What type of school do you teach in?
   - All-girls [ ] All-boys [ ] Mixed [ ]

5. Are your Junior Certificate science classes streamed or are they mixed-ability classes?
   - Streamed [ ] Mixed-ability [ ]

6. What is your favourite topic (if any) to teach on the Junior Certificate science course?
   __________________________________________

7. What is your least favourite topic (if any) to teach on the Junior Certificate science course?
   __________________________________________
8. Please give a reason why you chose this topic to be your **least** favourite to teach.

_________________________________________________________________________

_________________________________________________________________________

**Part 2 Teaching Methods Used for Junior Certificate Science**

1. How often do you do the followings things in your science classes? For each of the class activities, please rate how often you do them by placing a tick in the appropriate box.

<table>
<thead>
<tr>
<th>Class Activities</th>
<th>In almost all classes (75-100% of classes)</th>
<th>In most classes (50-74% of classes)</th>
<th>In some classes (25-49% of classes)</th>
<th>In hardly any classes (1-24% of classes)</th>
<th>Never (0% of classes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relate the science topic to the students’ daily lives.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Talk about the types of jobs that use science.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Give students notes to take down into their copies.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use group work (two or more people) when doing science activities (eg. experiment work, discussions, project work, answering questions)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have class discussions on</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
science topics.

<table>
<thead>
<tr>
<th>Carry out experiments for students to observe.</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Do practical work (eg. Little experiments, investigations, demonstrations) before introducing science theory.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. In your opinion, what is the best way to introduce a new science topic to Junior Certificate science students? Please write your answer in the space below.

__________________________________________________________________________

__________________________________________________________________________

3. Have you had any experience in inquiry-based science education projects/studies before?

Yes ☐ No ☐

4. Have you had any experience in context-based science education projects/studies before?

Yes ☐ No ☐

5. If you have answered ‘yes’ to questions 2 and/or 3, please comment on your prior experience of these projects.

__________________________________________________________________________

__________________________________________________________________________

Part 3 Students’ Feelings about Science in School

1. Do you believe that there is a difference between students’ level of interest in science between 1st and 3rd year in school?

Yes ☐ No ☐
2. If you answered ‘yes’ please comment on this, indicating whether it is a positive difference or negative difference in students’ interest in science.
3. Do you believe that the following statements best describe boys’ or girls’ sentiments in relation to their junior cycle science classes? If you feel that there are no differences for boys or girls, please place a tick in the ‘No difference’ box.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Girls</th>
<th>Boys</th>
<th>No difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Please place a tick in the appropriate box for each statement)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main concern in science class is getting a good grade.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prefers course material that arouses curiosity even if it is difficult to learn.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wants to do well in science class because it is important to show their ability to family, friends and teacher.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The science learned in school is more important than the grade they receive.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Likes to do better than other students on science tests.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nervous about how they will perform on science tests.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Believe that they can do extremely well in science if they put a lot of effort into studying it.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thank you very much for completing this questionnaire!
Letter to Principal

Title of Project: An Investigation of Factors Affecting Student Motivation in Junior Science and the Development and Evaluation of Strategies to Improve Student Motivation in Science

Dear Principal,

My name is Beulah McManus and I am a postgraduate student studying at the University of Limerick. I am carrying out a research project as part of my PhD. in order to gain a clear insight into the factors that affect student motivation in Junior Certificate science. This project aims to address the problem of students’ decline in motivation in Junior Certificate science and to discover where and why students “switch-off”. The focus of the research project is to evaluate the effectiveness of using context-based and inquiry-based approaches to motivate and reengage students in Junior Certificate science.

I’m writing this letter to you to enquire if the science teacher(s) and junior cycle science students would be interested in taking part in my study. The involvement of the science teachers from your school in this project would entail the completion of a 10-15 minute questionnaire. The questionnaire relates to teachers’ experiences of teaching science to junior cycle science students. The involvement of Junior Certificate science (1st-3rd year) students from your school in this project would also comprise of the completion of 10-15 minute questionnaire. The purpose of this questionnaire is to gain a clear insight into students’ motivation and attitudes towards science at the junior cycle level.

I have attached an information sheet with more detail about this project to this letter. Perhaps you could pass this information on to the science teachers in your school or alternatively, you could send me the names of the science teachers that would be interested in participating. My email address is Beulah.Mcmanus@ul.ie.

Yours sincerely,

Beulah McManus
Acceptance of the University of Limerick Child Protection Guidelines

I have read the University of Limerick Child Protection Guidelines and agree to abide by its contents. There is no reason why I would be considered unsuitable to work with children or young people.

Signature: ___________________________  Date: ____________

Print Name: ___________________________

Department: ___________________________

This form must be retained by the signatory’s University Department
Appendix 3b: Ethical Documentation

Part 2: Qualitative Study

Faculty of Science & Engineering Research Ethics Committee Full Application Form

<table>
<thead>
<tr>
<th>1</th>
<th>Title of Research Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>An Investigation into the Factors Affecting Students’ Motivation in Junior Cycle Science</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2</th>
<th>Period for which approval is sought</th>
</tr>
</thead>
<tbody>
<tr>
<td>March – June 2015</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3</th>
<th>Project Investigators</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>3a</th>
<th>Principal Investigator (Supervisor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Peter E. Childs</td>
</tr>
<tr>
<td>Department</td>
<td>Chemical and Environmental Sciences Department</td>
</tr>
<tr>
<td>Position</td>
<td>Director of Chemistry Education Research Group</td>
</tr>
<tr>
<td>Qualifications</td>
<td>M.A., D. Phil (Oxon)</td>
</tr>
<tr>
<td>Telephone Number</td>
<td>061 202486</td>
</tr>
<tr>
<td>e-mail address</td>
<td><a href="mailto:Peter.Childs@ul.ie">Peter.Childs@ul.ie</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3b</th>
<th>Other Investigators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Qualifications &amp; Affiliation</td>
</tr>
<tr>
<td>Teresa Curtin</td>
<td>Co-Supervisor, PhD.</td>
</tr>
<tr>
<td>Beulah McManus</td>
<td>B. Sc Education (Physical Sciences)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4</th>
<th>Head of Department(s)</th>
</tr>
</thead>
</table>

I have read through this application and am aware of the possible risks to participants involved in this study. I hereby authorise the Principal Investigator named above to conduct this research project.

<table>
<thead>
<tr>
<th>Name</th>
<th>Department</th>
<th>Date</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Tony Pembroke</td>
<td>CES</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Study Descriptors

*Please indicate the terms that apply to this research project*

<table>
<thead>
<tr>
<th>Healthy Adults</th>
<th>X</th>
<th>Healthy Children (&lt; 18 yrs)</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Adults</td>
<td></td>
<td>Patient Children (&lt; 18 yrs)</td>
<td></td>
</tr>
<tr>
<td>‘Potentially Vulnerable’ Adults</td>
<td></td>
<td>‘Potentially Vulnerable’ Children</td>
<td></td>
</tr>
<tr>
<td>Physical Activity</td>
<td></td>
<td>Questionnaire/Interview</td>
<td></td>
</tr>
<tr>
<td>Medical Devices / Drugs</td>
<td></td>
<td>Video Recording/Photography</td>
<td></td>
</tr>
<tr>
<td>Food/Drink Supplementation</td>
<td></td>
<td>Collection of Personal Details</td>
<td></td>
</tr>
<tr>
<td>Measure Physical in Nature</td>
<td></td>
<td>Measure Psychological in Nature</td>
<td></td>
</tr>
<tr>
<td>Body Tissue Samples</td>
<td></td>
<td>Observational</td>
<td></td>
</tr>
<tr>
<td>Body Fluids Samples (e.g. blood)</td>
<td></td>
<td>Record Based</td>
<td></td>
</tr>
</tbody>
</table>

### Project Design
**Justification for Research Project** *(Include reference to published work)*

Too many young students are being turned off science too soon. This problem exists internationally (Royal Society of Chemistry, 2008) and in Ireland (Smyth *et al.*, 2006). The 2011 *Trends in International Mathematics and Science Study* reported that 53% of the 4th grade students (9-10 years old) agreed that they “like learning science” but only 35% of 8th grade students (13-14 years old) did so (Martin *et al.*, 2012). In Ireland it has been noted that this stage (13-14 years old, second year in secondary school) is where students either engage or disengage from schooling (Smyth, 2009).

The research on the teaching methods employed in Irish secondary schools points to the dominance of didactic approaches (Gilleece *et al.*, 2009), even though many international studies show that young people favour experiential learning (Smyth *et al.*, 2005).

The focus of this project is to investigate the factors that affect students’ decline in motivation in Junior Cycle science in Ireland.

References:


6b Hypotheses or questions to be answered

1. What factors affect student motivation in junior cycle science from the perspective of both students and teachers?

2. If students’ motivation during the junior science course does decline, at what stage does this happen?

6c Plan of Investigation

At this stage of the project, a quantitative investigation has been carried out into junior cycle students’ motivation and attitudes towards studying science in school. Two questionnaires were designed, piloted and then implemented: a Student Questionnaire and a Teacher Questionnaire. The Student Questionnaire sought information about the students’ attitudes towards science, the teaching approaches used in their science lessons, their motivation in science and their plans for careers in science. The Teacher Questionnaire aimed to discover the factors which teachers perceive to affect their students’ motivation in science.

For this study a representative sample of 100 second-level schools was selected from the second-level schools in Munster (N=212) using stratified sampling (as the total cohort of schools in Munster are representative of the total national cohort). Three Teacher Questionnaires were sent to the 100 schools (N=300) and 68 were returned (22.67% response). The Student Questionnaires were administered to 11 schools which showed interest in participating: 1,427 Student Questionnaires were returned from 10 of the 11 interested schools (N=2330, 61.2%).

In order to delve further into the factors that affect students’ motivation in science a qualitative study will be carried out. There will be 3 schools chosen (from the original sample of 100 schools) to participate in this study: a secondary school, a vocational school and a community/comprehensive school. The participants for this study will include a science teacher and 3 groups of ~7 students from 1st, 2nd and 3rd year, from each participating school. A semi-structured interview will be carried out with the teacher involved. Short focus groups will be carried out with the students in their groups of ~7s.

6d Research procedures

Teacher interviews

Student focus groups

6e Associated risks to subjects

Teacher interview: There is a risk that teachers may feel embarrassed to disclose information about their teaching practices.

Student focus groups: There is a risk that some students may feel embarrassed sharing their opinions with their peers and with the facilitator.
NVIVO software will be used to analyse the qualitative data. In preparation for this, the researcher has attended An Introduction to NVIVO course, which was run on Tuesday 20th Jan 2015 by Ben Meehan from QDAtraining. A follow-up workshop will be attended next month called, Analysing Data with NVIVO.

The Teacher interviews and student focus groups will be carried out in the selected schools which are as follows:

School 1: Pobalscoil na Trionoide, Youghal, Co. Cork.
School 2: Ennis Community College, Ennis, Co. Clare.
7a. How will potential research participants be sourced and identified?

The potential participant schools have been involved in the quantitative aspect of this study already. The schools participated previously by completing the Teacher and Student Questionnaires (March – June 2014).

The potential student participants for the focus groups will be chosen at random within the selected class groups (1st, 2nd, 3rd year science classes).

7b. Will research participants be recruited via advertisement (poster, e-mail, letter)?

YES [X]  NO [ ]

If YES, please provide details below, or attach the recruitment advertisement if written.

See Principal Letter attached.

7c. How many participants will be recruited?

Male 33  33 Female

Provide further information if necessary

There will be 21 students chosen per school - 7 from 1st year, 7 from 2nd year and 7 from 3rd year.

There will be 3 participating schools and there will be one participating teacher from each school.

7d. What are the principal inclusion criteria? (Please justify)

Students: Students studying science for junior cycle.

Teachers: Teachers with (at least 1 years) experience teaching junior cycle science.
7e What are the principal exclusion criteria? *(Please justify)*
Students: Students not studying science for junior cycle.
Teachers: Teachers with no experience (or less than 1 years experience) teaching junior cycle science.

7f What is the expected duration of participation for each participant?
Teacher interview: 30 minutes.
Student focus groups: 35-40 minutes.

7g What is the potential for pain, discomfort, embarrassment, changes to lifestyle for the research participants?
None.

7h What arrangements have been made for participants who might not adequately understand verbal explanations or written information in English?
Every effort will be made to use simple language throughout the interview and through all correspondence with the research participants. This will be done by piloting the interview and focus groups with a group of young students (11-14 years old), science language education researchers.

7i 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)*

Yes X No ☐ N/A ☐

If Yes
Please state what these arrangements are:
If individual students do not wish to participate in the research, they do not need to partake in the focus group. These students will be able to remain in / return to their usual class.

It is not compulsory for teachers to partake in the interview either.
7j Will subjects receive any payments or incentives, or reimbursement of expenses for taking part in this research project?

YES [x] NO

If YES, please provide details below, and indicate source of funding:

8 Confidentiality of collected data

8a What measures will be put in place to ensure confidentiality of collected data?

All of the data collected will be transcribed with pseudo-names. Paper based data will be stored in a locked filing cabinet. Computer-based files will be password protected. The principal investigator and researcher will be the only people who will have access to this information.

8b Where will data be stored, i.e. Room Number?

F2-106
Second Floor,
Foundation Building,
University of Limerick.

8c Who will have custody and access to the data?

The principal investigator and the researcher will be the only people with access to this data

8d Data to be stored for 7 years after publication: How do you propose to store the information once the project is completed? Will the file/computer be password protected?

Explained above (8a).

Where will the information be stored (room number):

9 Drugs or Medical Devices
### Are Drugs or Medical Devices to be used?

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
</table>

If YES please complete 9a to 9c

<table>
<thead>
<tr>
<th>9a</th>
<th>Details of the Drugs or Devices (including name, strength, dosage, route of administration)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>9b</th>
<th>Details of Clinical Trial Certificate, Exemption Certificate or Product Licence (The Product Licence must cover the proposed use in the Project)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>9c</th>
<th>Details of any Risks (Both to subjects and staff; indicate current experience with the drug or device)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

### 10 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](http://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: [Signature]
Please note: failure to provide the necessary documentation will delay the consideration of the application. Please complete the checklist below:

**Documents**

<table>
<thead>
<tr>
<th>Document</th>
<th>Included?</th>
<th>YES</th>
<th>X</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant Information Sheet</td>
<td>YES</td>
<td></td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>Participant Consent From</td>
<td>YES</td>
<td></td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>Parent/Guardian Information Sheet</td>
<td>YES</td>
<td></td>
<td></td>
<td>N/A</td>
</tr>
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<td>Parent/Guardian Consent Form</td>
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<td></td>
<td></td>
<td>N/A</td>
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<td>School Principal Information Sheet</td>
<td>YES</td>
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<td></td>
<td>N/A</td>
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<td>School Principal Consent Form</td>
<td>YES</td>
<td></td>
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<td>N/A</td>
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<tr>
<td>Teacher Information Sheet</td>
<td>YES</td>
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<td></td>
<td>N/A</td>
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<td>Teacher Consent Form</td>
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<td>N/A</td>
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<tr>
<td>Questionnaire/Interview/Survey Questions</td>
<td>YES</td>
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<td></td>
<td>N/A</td>
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<td>Recruitment Letters/Advertisements/Emails</td>
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<td>N/A</td>
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<tr>
<td>Acceptance of UL Child Protection Form</td>
<td>YES</td>
<td></td>
<td></td>
<td>N/A</td>
</tr>
</tbody>
</table>

Please ensure any additional documents are included with this application. These should be attached as a single document and included in the e-mail submission.
12 Declaration

The information in this application form is accurate to the best of my knowledge and belief, and I take full responsibility for it.

I undertake to abide by the ethical principles outlined in the Science & Engineering Research Ethics Committee guidelines.

If the research project is approved, I undertake to adhere to the study protocol without unagreed deviation, and to comply with any conditions sent out in the letter sent by the Science & Engineering Research Ethics Committee notifying me of this.

I undertake to inform the Science & Engineering Research Ethics Committee of any changes in the protocol, and to submit a Report Form upon completion of the research project.

<table>
<thead>
<tr>
<th>Name of Principal Investigator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signature of Principal Investigator</td>
</tr>
<tr>
<td>(or Head of Department*)</td>
</tr>
<tr>
<td>Date</td>
</tr>
</tbody>
</table>

*Please note: where the Principal Investigator is not a permanent employee of the University of Limerick, the relevant Head of Department should sign this declaration.

1. Once completed, this form along with a single document containing any additional documentation should be submitted electronically to the Faculty Office, Science & Engineering at SciEngEthics@ul.ie

2. In addition, 1 copy of the fully signed application and any attachments should be submitted to:
   The Secretary,
   Faculty of Science & Engineering Research Ethics Committee,
   University of Limerick
Letter to Principal

Title of Project: An Investigation of Factors Affecting Student Motivation in Junior Cycle Science

Dear Principal,

My name is Beulah McManus and I am a postgraduate student studying at the University of Limerick. I am carrying out a research project as part of my Masters in order to gain a clear insight into the factors that affect student motivation in Junior Certificate science. This project aims to address the problem of students’ decline in motivation in Junior Certificate science and to discover where and why students “switch-off”.

I’m writing this letter to you to enquire if the Junior Certificate science teacher and small groups of junior cycle science students from your school would be interested in taking part in my study. The involvement of the science teacher from your school in this project would entail the completion of a 40 minute interview based on how they feel their Junior Certificate science students view science in school and the issues that affect this. This interview will be audio recorded.

The involvement of students in the study would comprise of of ~7 Junior Certificate science students (from 1st, 2nd and 3rd years respectively) partaking in 35-40 minute focus groups. One focus group will be conducted with each group of ~ 7 students and they will also be audio recorded. The purpose of the focus groups is to gain a clear insight into the students’ perspective of what motivates/demotivates them in their study of Junior Certificate science. All audio recordings will be destroyed once the project is completed.

I have attached an information sheet with more details about this project to this letter. Perhaps you could pass this information on to the science teachers in your school or alternatively, you could send me the name of the science teacher that would be interested in participating. My email address is Beulah.Mcmanus@ul.ie.

Yours sincerely,

Beulah McManus
Title of Project: An Investigation of Factors Affecting Student Motivation in Junior Cycle Science

Introduction:

I am a postgraduate student studying at the University of Limerick. I am carrying out a research project as part of my Masters in order to gain a clear insight into the factors that affect student motivation in Junior Certificate science.

Background to the project:

This project aims to address the problem of students’ decline in motivation in Junior Certificate science and to discover where and why students “switch-off”. It has been found that young people entering secondary school generally have positive attitudes towards science. However, this declines most sharply between the ages of 11 and 14 (Bennett and Hogarth 2005).

To date, a large scale quantitative study has been carried out as part of this Masters project, using Teacher and Student Questionnaires. However, in order to delve further into the factors that affect students’ motivation in science I feel that it is necessary to conduct a qualitative study, through the use of Teacher Interviews and small Student Focus Groups.

What does this study entail for your school?

The involvement of the Junior Certificate science teacher from your school in this project will entail the completion of a 40 minute interview based on how they feel their Junior Certificate science students view science in school and the issues that affect this. This interview will be audio recorded.

The involvement of three groups of ~7 Junior Certificate science students (from 1st, 2nd and 3rd years respectively) from your school in this project will comprise of the completion of 35-40 minute focus groups. One focus group will be conducted with each group of ~7 students and they will also be audio...
recorded. The purpose of the focus groups is to gain a clear insight into the students’ perspective of what motivates/demotivates them in their study of Junior Certificate science.

All audio recordings will be destroyed once the project is completed.

Confidentiality:

All collected information will be held in strict confidence. Your school’s identity and the identity of the science teacher and pupils will remain anonymous through the use of pseudonyms. Students and teachers are under no obligation to participate in this study and they have the right to withdraw at any stage. There are no risks associated with this study.

Should you have any questions, please contact the investigators and we will clarify any issues that you are concerned about.

Principal Investigator:

Peter E. Childs (061 202486) Peter.Childs@ul.ie

Investigators:

Beulah McManus Beulah.Mcmanus@ul.ie

If you wish to contact somebody that is independent of this project, you may contact: The Chair, Faculty of Science and Engineering Research Ethics Committee, University of Limerick, Limerick. Tel: 061 202802.

Thank you for taking the time to consider participating in this study.

Kind Regards,

Beulah McManus
Title of Project: An Investigation of Factors Affecting Student Motivation in Junior Cycle Science

Introduction:

I am a postgraduate student studying at the University of Limerick. I am carrying out a research project as part of my Masters in order to gain a clear insight into the factors that affect student motivation in Junior Certificate science.

Background to the project:

This project aims to address the problem of students’ decline in motivation in Junior Certificate science and to discover where and why students “switch-off”. It has been found that young people entering secondary school generally have positive attitudes towards science. However, this declines most sharply between the ages of 11 and 14 (Bennett and Hogarth 2005).

To date, a large scale quantitative study has been carried out as part of this Masters project, using Teacher and Student Questionnaires. However, in order to delve further into the factors that affect students’ motivation in science I feel that it is necessary to conduct a qualitative study, through the use of Teacher Interviews and small Student Focus Groups.

What does this study entail for your school?

If you wish to take part in this study, you will be asked to take part in a 40 minute interview based on how you feel your Junior Certificate science students view science in school and the issues that affect this. This interview will be audio recorded. All audio recordings will be destroyed once the project is completed.

Confidentiality:

All collected information will be held in strict confidence. Your identity and your school’s identity will remain anonymous through the use of pseudonyms. You are under no obligation to participate in
this study and you have the right to withdraw at any stage. There are no risks associated with this study.

Should you have any questions, please contact the investigators and we will clarify any issues that you are concerned about.

**Principal Investigator:**

Peter E. Childs (061 202486) [Peter.Childs@ul.ie](mailto:Peter.Childs@ul.ie)

**Investigators:**

Beulah McManus [Beulah.Mcmanus@ul.ie](mailto:Beulah.Mcmanus@ul.ie)

If you wish to contact somebody that is independent of this project, you may contact: The Chair, Faculty of Science and Engineering Research Ethics Committee, University of Limerick, Limerick. Tel: 061 202802.

Thank you for taking the time to consider participating in this study.

Kind Regards,

Beulah McManus
Title of Project: An Investigation of Factors Affecting Student Motivation in Junior Cycle Science

Introduction:

I am a postgraduate student studying at the University of Limerick. I am carrying out a research project as part of my Masters in order to gain a clear insight into the factors that affect student motivation in Junior Certificate science.

Background to the project:

This project aims to address the problem of students’ decline in motivation in Junior Certificate science and to discover where and why students “switch-off”. It has been found that young people entering secondary school generally have positive attitudes towards science. However, this declines most sharply between the ages of 11 and 14 (Bennett and Hogarth 2005).

To date, a large scale quantitative study has been carried out as part of this Masters project, using Teacher and Student Questionnaires. However, in order to delve further into the factors that affect students’ motivation in science I feel that it is necessary to conduct a qualitative study, through the use of small Student Focus Groups.

What does this study entail for your son/daughter?

The involvement of your son/daughter in this project will comprise of the completion of 35-40 minute focus group (group interview). This focus group will be carried out in the school, with a group of ~7 students from the same year and it will be audio recorded. The purpose of the focus group is to gain a clear insight into the students’ perspective of what motivates/demotivates them in their study of Junior Certificate science.

All audio recordings will be destroyed once the project is completed.

Confidentiality:
All collected information will be held in strict confidence. Your child’s identity will remain anonymous. Pseudonyms will be used when reporting on the focus groups in the Masters thesis. Your son/daughter is under no obligation to participate in this study and they have the right to withdraw at any stage. There are no risks associated with this study.

Should you have any questions, please contact the investigators and we will clarify any issues that you are concerned about.

Principal Investigator:

Peter E. Childs (061 202486) Peter.Chilts@ul.ie

Investigators:

Beulah McManus Beulah.Mcmanus@ul.ie

If you wish to contact somebody that is independent of this project, you may contact: The Chair, Faculty of Science and Engineering Research Ethics Committee, University of Limerick, Limerick. Tel: 061 202802.

Thank you for taking the time to consider participating in this study.

Kind Regards,

Beulah McManus
Student Information Sheet

Title of Project: An Investigation of Factors Affecting Student Motivation in Junior Cyle Science

Introduction:

I am a student studying at the University of Limerick. I am carrying out a research project as part of my Masters in order to understand how students feel about their study of science in school.

Background to the project:

The aim of this project is to understand why students experience a decline in motivation in Junior Certificate science. Studies have found that young people enter secondary school with positive attitudes towards science. However, these studies have also shown that students lose these positive attitudes towards science between the ages of 11 and 14. The focus of my project is to gain your opinion of your experience of science in school and to discover why you think students’ positive attitudes towards science may decline.

What do I have to do?

If you would like to take part in this study, all you have to do is take part in a group interview with ~ 6 other students from your class. This interview will be based on your feelings towards science in school. The interview will be audio recorded but all recordings will be destroyed once the project is completed.

Confidentiality:

You do not have to use your real name in the interview. You do not have to take part in this study if you do not want to, and you can stop taking part in the project at any stage. There are no risks associated with this study.

If you have any questions, please contact the investigators and we will clarify any issues that you are concerned about.

Principal Investigator:
Investigators:

Beulah McManus Beulah.Mcmanus@ul.ie

If you wish to contact somebody that is independent of this project, you may contact: The Chair, Faculty of Science and Engineering Research Ethics Committee, University of Limerick, Limerick. Tel: 061 202802.

Thank you for taking the time to consider participating in this study.

Kind Regards,

Beulah McManus
Principal Consent Form

Title of Project: An Investigation of Factors Affecting Student Motivation in Junior Cycle Science.

- I have read and understand the subject information sheet.
- I am fully aware of the procedures involved.
- I understand what the project is about and what the results obtained will be used for.
- I am aware that the students’/teacher’s participation in this study may be audio recorded and I agree to this. However, should they feel uncomfortable at any time they can request that the recording equipment be switched off. They are entitled to copies of transcripts of the recordings on request. The recordings will be destroyed once the study is completed.
- I am aware that any personal information and results collected will remain confidential.
- I understand that all student and teacher participation is voluntary and that they are able to withdraw from the project at any stage.

Principal’s Signature: ____________________________ Date: ____________
Investigator’s Signature: ____________________________ Date: ____________
**Teacher Consent Form**

**Title of Project:** An Investigation of Factors Affecting Student Motivation in Junior Cycle Science

- I have read and understand the subject information sheet.
- I am fully aware of the procedures involved.
- I understand what the project is about and what the results obtained will be used for.
- I am aware that my participation in this study may 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 transcripts of my recordings on request, and I know that the recordings will be destroyed once the study is completed.
- I am aware that any personal information and results collected will remain confidential.
- I understand that my participation is voluntary and I am able to withdraw from the project at any stage.

Participant’s Signature: ___________________________ Date: _______________

Investigator’s Signature: ___________________________ Date: _______________
Title of Project: An Investigation of Factors Affecting Student Motivation in Junior Cycle Science

- I have read and understand the subject information sheet.
- I am fully aware of the procedures involved.
- I understand what the project is about and what the results obtained will be used for.
- I am aware that my son’s/daughter’s participation in this study may be audio recorded and I agree to this. However, should my son/daughter feel uncomfortable at any time he/she can request that the recording equipment be switched off. He/she is entitled to copies of transcripts of the recordings on request and the recordings will be destroyed once the study is completed.
- I am aware that any personal information and results collected will remain confidential.
- I understand that the student’s participation is voluntary and they are able to withdraw from the project at any stage.

Parent’s/Guardian’s Signature:_________________________ Date:_________________________

Investigator’s Signature:_______________________________ Date:_________________________
**Student Consent Form**

**Title of Project:** An Investigation of Factors Affecting Student Motivation in Junior Cycle Science

- I have read and understand the subject information sheet.
- I am fully aware of the procedures involved.
- I understand what the project is about and what the results obtained will be used for.
- I am aware that my participation in this study may 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 transcripts of my recordings on request.
- I am aware that any personal information and results collected will remain confidential.
- I understand that my participation is voluntary and I am able to withdraw from the project at any stage.

Participant’s Signature: ____________________ Date: _______________

Investigator’s Signature: ____________________ Date: _______________
Teacher Interview Questions
Junior Certificate Science Teacher Interview

• Does students’ motivation in science change as they progress through school do you think? If so, why?

• Is this change in motivation/engagement apparent across all subjects or is it more specific to science? Please explain.

• What factors do you feel affect students’ motivation in junior cycle science?

• How would you describe the culture of this school?

• How would you describe the relationship you have with your first/second/third year science class groups?

• Does the relationship with your science students change as they progress through the Junior Cycle, if so, how?

• What impact do you feel the Junior Certificate examination has on students’ motivation in science?

• How do you feel you can motivate your students in science?

• Is it possible to reengage disengaged/unmotivated students in science at junior cycle?
Student Focus Groups

- Do you like science in school? Why?
- Do you find science in school difficult?
- What, to you, is good science teaching?
- What, to you, is bad science teaching?
- Do you ever learn about science outside of school? Where/how?
- What helps you to learn in science class?
- Is it “cool” to like science in school?
- What did you think about science in school last year?
- Is it different to how you feel about it now? If so, why?
Acceptance of the University of Limerick Child Protection Guidelines

I have read the University of Limerick Child Protection Guidelines and agree to abide by its contents. There is no reason why I would be considered unsuitable to work with children or young people.

Signature: ___________________ Date: ______________

Print name: _____________________

Department: ___________________
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<thead>
<tr>
<th>Significant Difference</th>
<th>P Value</th>
<th>Non-Significant Difference</th>
<th>P Value</th>
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<td>Science classes bore me.</td>
<td>0.05</td>
<td>Science is a difficult subject</td>
<td>0.063</td>
</tr>
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<td>I can easily understand new ideas in science.</td>
<td>0.000</td>
<td>Science in school is interesting.</td>
<td>0.421</td>
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<td>I don’t understand the point of learning science in school.</td>
<td>0.002</td>
<td>I would like to have as much science as possible at school.</td>
<td>0.157</td>
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<tr>
<td>Science in school is easy for me.</td>
<td>0.018</td>
<td>What I learn in science classes helps me to make sense of things</td>
<td>0.075</td>
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<td></td>
<td></td>
<td>in my everyday life.</td>
<td></td>
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<td>I copy notes the teacher gives me into my copy book.</td>
<td>0.001</td>
<td>I would enjoy school more if there were no science classes.</td>
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<td>I link what I learn in science to what I learn in other subjects.</td>
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<td>I look forward to science class.</td>
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<td>I will never be able to get an excellent grade in a science test</td>
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<td>School science has made me wonder about the things we cannot</td>
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<td>explain yet.</td>
<td></td>
</tr>
<tr>
<td>I feel good when I manage to understand a difficult science idea.</td>
<td>0.010</td>
<td>I link what I learn about science to my everyday life.</td>
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<td>I want to do well in science class because it is important to</td>
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<td>I hear about the types of jobs that use science.</td>
<td>0.463</td>
</tr>
<tr>
<td></td>
<td></td>
<td>show my family, friends and teacher that I am able to do well.</td>
<td></td>
</tr>
<tr>
<td>I am not as good at science as most of the other students in my</td>
<td>0.000</td>
<td>I explain my own ideas about each new science topic to the</td>
<td>0.074</td>
</tr>
<tr>
<td></td>
<td></td>
<td>teacher.</td>
<td></td>
</tr>
<tr>
<td>If I work hard enough I will be able to understand all of the</td>
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<td>I listen or get involved in discussions in class about science</td>
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</tr>
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<td>in the news.</td>
<td></td>
</tr>
<tr>
<td>I find that science has lots of ideas that I can understand.</td>
<td>0.000</td>
<td>I write my experiments into my lab notebook.</td>
<td>0.163</td>
</tr>
<tr>
<td>I would like to become a scientist.</td>
<td>0.001</td>
<td>I get the chance to do hands-on, investigating work <strong>before</strong></td>
<td>0.092</td>
</tr>
<tr>
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<td>looking at the theory.</td>
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<td>Score</td>
<td>Response</td>
<td>Score</td>
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<td>When I grow up I would like to work with people who make discoveries in science.</td>
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<tr>
<td>I would not like to be a scientist because the work would be too hard.</td>
<td>0.002</td>
<td>I think about a science problem <strong>before</strong> it is explained to me by the teacher.</td>
<td>0.439</td>
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<tr>
<td>Science has opened my eyes to new and exciting jobs.</td>
<td>0.004</td>
<td>I do an experiment to test out my ideas on a science problem.</td>
<td>0.589</td>
</tr>
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<td>My main goal in science class is to get a good grade.</td>
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<td>0.133</td>
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<td>I really like science that is interesting even if it is difficult to learn.</td>
<td></td>
<td></td>
<td>0.343</td>
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<td>If I do badly in a science test it is because I did not study hard enough.</td>
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<tr>
<td>I believe that I can do very well in science tests if I put a lot of effort into studying it.</td>
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<td>I really like learning new things in science class.</td>
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<td>A job as a scientist would be too boring.</td>
<td></td>
<td></td>
<td>0.486</td>
</tr>
<tr>
<td>Science is important for helping us to understand the world.</td>
<td></td>
<td></td>
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<td>I would like to study science subjects for my Leaving Cert.</td>
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<tr>
<td>------------------------</td>
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<td>---------</td>
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<tr>
<td>Science is a difficult subject</td>
<td>0.005</td>
<td>Science classes bore me.</td>
<td>.738</td>
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<tr>
<td>Science in school is interesting.</td>
<td>0.004</td>
<td>What I learn in science classes helps me to make sense of things in my everyday life.</td>
<td>.112</td>
</tr>
<tr>
<td>I would like to have as much science as possible at school.</td>
<td>0.002</td>
<td>Science in school is easy for me.</td>
<td>0.683</td>
</tr>
<tr>
<td>I would enjoy school more if there were no science classes.</td>
<td>0.001</td>
<td>I link what I learn about science to my everyday life.</td>
<td>0.082</td>
</tr>
<tr>
<td>I look forward to science class.</td>
<td>0.006</td>
<td>I hear about the types of jobs that use science.</td>
<td>0.106</td>
</tr>
<tr>
<td>I can easily understand new ideas in science.</td>
<td>0.012</td>
<td>I listen to the teacher explain science ideas.</td>
<td>0.146</td>
</tr>
<tr>
<td>I don’t understand the point of learning science in school.</td>
<td>0.001</td>
<td>I link what I learn in science to what I learn in other subjects.</td>
<td>0.274</td>
</tr>
<tr>
<td>School science has made me wonder about the things we cannot explain yet.</td>
<td>0.003</td>
<td>I think about a science problem before it is explained to me by the teacher.</td>
<td>0.466</td>
</tr>
<tr>
<td>I copy notes the teacher gives me into my copy book.</td>
<td>0.000</td>
<td>My main goal in science class is to get a good grade.</td>
<td>0.145</td>
</tr>
<tr>
<td>I explain my own ideas about each new science topic to the teacher.</td>
<td>0.000</td>
<td>I will never be able to get an excellent grade in a science test no matter how hard I try.</td>
<td>0.176</td>
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<tr>
<td>I listen or get involved in discussions in class about science in the news.</td>
<td>0.005</td>
<td>I feel good when I manage to understand a difficult science idea.</td>
<td>0.059</td>
</tr>
<tr>
<td>I write my experiments into my lab notebook.</td>
<td>0.000</td>
<td>I believe that I can do very well in science tests if I put a lot of effort into studying it.</td>
<td>0.093</td>
</tr>
<tr>
<td>I get the chance to do hands-on, investigating work before looking at the theory.</td>
<td>0.004</td>
<td>I want to do well in science class because it is important to show my family, friends and teacher that I am able to do well.</td>
<td>0.247</td>
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<tr>
<td>I do an experiment to test out my ideas on a science problem.</td>
<td>0.015</td>
<td>I find that science has lots of ideas that I can understand.</td>
<td>0.452</td>
</tr>
<tr>
<td>I really like science that is interesting even if it is difficult to learn.</td>
<td>0.004</td>
<td>A job as a scientist would be too boring.</td>
<td>0.095</td>
</tr>
<tr>
<td>---</td>
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<td>---</td>
<td>---</td>
</tr>
<tr>
<td>If I do badly in a science test it is because I did not study hard enough.</td>
<td>0.010</td>
<td>I would not like to be a scientist because the work would be too hard.</td>
<td>0.553</td>
</tr>
<tr>
<td>I am not as good at science as most of the other students in my class.</td>
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<tr>
<td>I really like learning new things in science class.</td>
<td>0.004</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If I work hard enough I will be able to understand all of the science topics on the course.</td>
<td>0.011</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would like to become a scientist.</td>
<td>0.011</td>
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</tr>
<tr>
<td>Science is important for helping us to understand the world.</td>
<td>0.000</td>
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</tr>
<tr>
<td>When I grow up I would like to work with people who make discoveries in science.</td>
<td>0.001</td>
<td></td>
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</tr>
<tr>
<td>Science has opened my eyes to new and exciting jobs.</td>
<td>0.016</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would like to study science subjects for my Leaving Cert.</td>
<td>0.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>