Supporting Discourse using Technology-Mediated Communication:
A Model for Enhancing Practice in Second Level Education

A thesis submitted to the University of Limerick for the degree of

Doctor of Philosophy

by

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Declaration

I declare this thesis, which I submit to the University of Limerick for examination in consideration for degree of Doctor of Philosophy is of my own personal effort and is not being submitted for any other degree, nor has been accepted for any other degree.

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Statement

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Abstract

Despite the pervasiveness of Information and Communication Technology (ICT) in our daily lives, such technology has not been as widely adopted in formal education. When ICT is used within the classroom, its impact on pupil learning is mixed at best. However, technology is linked with better learning in some contexts, such as when ICT extends teaching and learning and enhances classroom practice (OECD 2015). The nature of design-based activity within the classrooms of Design and Technology (D&T) education gives a critical context for this research, as it develops the pupil-centred approaches and formative practices for teaching and learning shown to have strong associations with the effective use of ICT to enhance practice (OECD 2015). However, we have not yet become good enough at the kind of pedagogy that makes the most of technology and the effectiveness of teaching and learning (OECD 2015). Accordingly, it is argued that supporting discourse is a precursor for the effective use of ICT in teaching and learning, and technology-mediated communication (TMC) provides a medium for supporting discourse between teachers and pupils. Therefore, in the context of supporting discourse using technology-mediated communication, the aim of this research was to conduct an exploratory study which investigates the development of a conceptual model for enhancing practice in second level education.

In conjunction with ICT, this study implemented the use of ‘learning protocols’, as both a pedagogical and technological approach for supporting discourse using TMC. The research participants included, senior-cycle pupils ($n = 87$) of D&T education, and pre-service teachers ($n = 7$) of Initial Technology Teacher Education (ITTE). The research method adopted a design experiments approach with mixed-methods, and included transcript analysis, teacher interviews, pupil focus groups, and surveys.

In the context of supporting discourse using technology-mediated communication, the integration of a conceptual model for enhancing practice using learning protocols generated a common language of understanding between teachers and pupils, and the nature of discourse and the language of that discourse were shown to be cognitive. Furthermore, supporting discourse using technology-mediated communication, had a positive effect on interest, motivation and engagement within the process of learning and the general perception is that it extends and enhances the conditions for learning.
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1 Introduction
1.1 Background

In Ireland, the Organisation for Economic Co-operation and Development (OECD) reported that in 2012, 98% of 15-year-old pupils have at least one computer at home, but only 64% of pupils reported that they use a computer, laptop or tablet at school. These findings are based on an analysis of the Programme for International Student Assessment (PISA) data and show that despite the pervasiveness of Information and Communication Technology (ICT) in pupils’ daily lives, such technologies have not yet been as widely adopted within the classrooms of formal second level education. When they are used in the classroom, their impact on pupil learning is mixed at best. However, technology is linked with better learning in some contexts, such as when ICT extends teaching and learning and enhances classroom practice (OECD 2015). When ICT supports the pupils’ engagement in challenging material, thus extending the learning and enhancing classroom practice or helps pupils to assume a greater control over the learning situation, by individualising the pace of which new material is introduced or by providing immediate feedback, pupils learn more, (OECD 2015).

The strongest associations between the use of ICT and enhancing practice are pupil-centred approaches and formative practices for teaching and learning, which include individualised pace and feedback, collaborative learning and project-based learning.

The tendency to use the acronym of ICT instead of IT (Information Technology) reflects a growing recognition that information is framed within the contexts and imperatives of communication and technology is a media of and for communication. Likewise, in education there is a growing recognition that ICT needs to be linked to conversations within social contexts and to communities of learning (Richards 2006) to create an integrated approach for designing effective ICT-supported environments.

A conversational framework (Laurillard 2002), captures the essence of teaching as an iterative dialogue between teachers and learners while functioning on two levels: 1) a discursive, theoretical, conceptual level; 2) an active, practical, experiential level i.e., the levels bridged by teachers and pupils engaging within the process of critical thinking (practice in relation to theory) and reflection (theory in the light of practice). A community of learning as defined by Ludwig-Hardman and Dunlap (2003) is a “group of people connected via technology-mediated communication, who actively engage one another in collaborative learner-centred activities to intentionally foster
the creation of knowledge, while sharing a number of values and practices”, (p. 10),
It is clear that what teachers and pupils do with technology and how they do it is a
critical aspect in the meaningful integration of ICT in the classroom environment.
However, if ICT is to make any real contributions to both teaching and learning, then
supporting communication between teachers and pupils needs careful consideration.

1.1.1 Design and Technology

As schools and teachers look to integrate systems of ICT in their classroom practice,
Design and Technology (D&T) has continued to be recognised as a potentially rich
environment to investigate their role in teaching and learning (McCormick 2004).
This is because the nature of designing in D&T education is a conversational activity
(Hamilton 2003, 2004; Hennessy & Murphy 1999; Murphy & Hennessy 2001), that
draws on both teacher-pupil and pupil-pupil interactions within the social context.
D&T education also has the potential to exploit ICT in a way that can transform both
teaching and learning in a way that has not yet been done so far (McCormick 2004),
as it affords pupils the opportunities for interaction, even when these are not made
explicit by the pedagogic stance adopted by the teacher (Murphy & Hennessy 2001).
Thus, D&T places conversation at the core of the educational process (Trebell 2007),
providing both the context and the opportunities in which ICT can enhance practice
through individualised feedback, collaborative learning and project-based learning.

In Ireland, D&T education at second level has always met the challenge of keeping
up with emerging ICT (McGarr 2011). The history of D&T curricula is dotted with
changes to its subject content and influenced by the emergence of new technologies.
From the development of the microprocessor to the growth of computer-aided design
D&T education has altered the content of syllabi to incorporate these advancements.
Recently, the suite of D&T subjects in Ireland has undergone significant changes.
These changes mark “a shift from the traditional focus of the subjects, aimed at
developing craft skills and technical competence, to one that focuses on the
development of transferrable knowledge, skills and attitudes” (McGarr 2011, p. 1).

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1 In Ireland, second level education is classified into junior (age: 12-15) and senior (age: 15-18) cycle.
Design and Technology (D&T) education at second level is offered as part of the following subjects:
Technology, Materials Technology (Wood), Metalwork, and Technical Graphics at junior cycle level;
Technology, Construction, Engineering, and Design & Communication Graphics at senior cycle level.
This shift also mirrors an international move “from the transmission of facts or the
demonstration of skills towards the development of active, autonomous learners”
(Dow 2006, p. 309). Such changes attempt to “encourage the active involvement of
pupils in authentic and meaningful learning experiences” (Dow 2006, p. 307) with
the integration of more collaborative practices. In this context D&T education is well
placed within the curriculum to begin to build and establish a community of learners.

1.1.2 Community of Learning

While D&T creates the settings for a community of learners, a community itself will
not be meaningful unless teachers and pupils actually communicate with each other.
Hence, the implementation of a theoretical framework that supports communication
is of critical importance, as the most common pitfall in ICT-supported learning is
taking for granted that communication will automatically take place just because an
environment makes it technologically possible (Kreijns, Kirschner & Jochems 2003).

The Community of Inquiry (CoI) model (Garrison, Anderson & Archer 2000),
represents a process of creating a deep and meaningful learning experience through
social, cognitive and teaching presence. Social presence is “the ability of participants
to [...] communicate purposefully in a trusting environment and develop inter-
personal relationships by way of projecting their individual personalities” (Garrison,
2009, p. 352). Cognitive presence is “the extent to which the participants [...] are
able to construct meaning through sustained communication”, (Garrison et al. 2000,
p. 11). Teaching presence is “the design, facilitation, and direction of cognitive and
social processes for the purpose of realising personally meaningful and educationally
Therefore, social, cognitive and teaching presence begins to inform the processes for
supporting communication between teachers and learners in second level education.

Garrison et al. (2000) first developed the CoI model to investigate how the features
of text-based language used in technology-mediated communication (TMC) might
promote both critical thinking and reflection. TMC is the hallmark of ICT-supported
learning because it allows teachers and learners to structure dialogue much like how
educational transactions develop in traditional classrooms (Garrison & Shale 1990).
The ability to structure communication much like a traditional classroom is critical, as the integration of ICT in the classroom should be considered as a pedagogical tool or resource for teaching and learning and not a repository of data and information. Hence, the emphasis should be on how the integration of ICT in the classroom can support communication in the educational transaction if ICT is to enhance practice through individualised feedback, collaborative learning and project-based learning. In the context of D&T this would include supporting communication with the use of scaffolded interactions where the act of designing becomes the focus of conversation with the interactions being seen as a tool to develop a mutually appropriated concept. It is becoming increasingly clear that there is a synergy between the practice of D&T and the CoI processes, where the integration of the both, creates the conditions for supporting communication between teachers and learners in second level education.

1.2 Research Questions

If we consider using the CoI model for the integration of ICT within D&T education teaching presence, (i.e. the design, facilitation, and direction of social and cognitive processes), will have a significant influence on the teaching and learning experience. Moreover, if the design, facilitation and direction of social and cognitive processes are to play such a key role in teaching and learning, then it makes sense to first look at the intersection between social and cognitive presence (i.e. supporting discourse). Here, teachers and learners move beyond the simple transmission of information to a more reflective interchange of thoughts, feelings and ideas (Redmond & Lock 2006). As was originally described by Foucault (in Weedon 1987, p. 108) discourse is more than just another form of communicating, thinking, working or producing meaning, discourse is a form of constituting knowledge, together with social practices, forms of subjectivity and power which exists in knowledge and the relations between them. Thus, ICT should focus on discourse and supporting discourse, not communication. Pfister and Mühlpfordt (2002) offer empirical results which confirms the hypothesis that supporting discourse leads to meaningful and educationally worthwhile learning. According to Pfister and Mühlpfordt (2002) supporting discourse involves the use of learning protocols to increase the structure and efficiency of teaching and learning. This approach provides a support for discourse where teachers and pupils explicitly identify (code) the reference of their contribution, as well as the type of contribution.
However, the real contributions learning protocols can make to teaching and learning are yet to be fully exploited within the classrooms of formal second level education. Hence, this research will conduct an exploratory study which investigates the role of learning protocols on supporting discourse using TMC within design-based activity in second level education. Accordingly, the following questions guided this research:

1. How can supporting discourse using technology-mediated communication in education inform both the process and the evidence of teaching and learning?

2. What is the relationship between the technological and pedagogical approach required for supporting discourse using technology-mediated communication, and their capacity for extending teaching and learning beyond the classroom?

3. What is the perceived effect between supporting discourse using technology-mediated communication and enhancing practice for teaching and learning?

1.2.1 Research Aim

Though Anderson et al. (2001) have focused on “realising […] learning outcomes”, learning outcomes do very little to inform the process of either teaching or learning. For that reason, this research argues that it would be clearly more useful to focus on evidencing a personally meaningful and educationally worthwhile learning process, rather than retrospectively concentrating on those outcomes that have been achieved.

The capacity to identify pupils’ current and targeted progressions is a critical skill for teachers in deciding if they should or shouldn’t intervene in their process of learning. To do so in an effective manner is difficult even for the most experienced teachers. For this to work both in theory and practice, for teachers and pupils alike to base their intervention strategies and decisions on evidence, protocols based on a common language of progression have got to first be established in order to support discourse. In the context of supporting discourse using technology-mediated communication, the aim of this research was to conduct an exploratory study which investigates the development of a conceptual model for enhancing practice in second level education.
1.2.2 Research Objectives

In an effort to fully attend to the proposed research aim, this study will endeavour to:

- Develop a theoretical understanding around the processes and conditions of contemporary teaching and learning that can be supported by the integration of technology-mediated communication within formal design-based activity.

- Develop a conceptual model based on these processes and conditions for the purposes of supporting discourse using technology-mediated communication.

- Examine a pedagogical approach to supporting discourse using technology-mediated communication that helps teachers and pupils articulate a common language of understanding based on the processes and conditions of learning.

- Based on the conceptual model, evaluate teachers and pupils’ response to the design and integration of the pedagogical approach for supporting discourse.
2 Literature Review
2.1 Overview

The following section will frame two ideas this research is proposing to synthesise:
1) supporting discourse is a precursor for effective teaching and learning in schools;
2) technology-mediated communication provides a medium for supporting discourse.

The Importance of Supporting Discourse

The correlation between communication in the classroom and effective teaching and learning has been so well documented that debates about the use and justification of communication in the classroom have been replaced by conversations of inevitability where classrooms rich in communication are presented as effective sites for learning. However, the focus should be on ‘discourse’, not communication, in the classroom, even though ‘discourse’ is not easily or well defined, nor easily or well ‘supported’.

As previously stated Foucault (in Weedon 1987, p. 108) described discourse as more than just another form of communicating, thinking, working or producing meaning. Communication is best understood as the imparting or transmission of information while discourse is understood as being the interchange of thoughts, feelings or ideas. As was also mentioned, the most common pitfall in ICT-supported learning is taking for granted that social interaction will automatically take place just because an environment makes it technologically possible (Kreijns, Kirschner & Jochems 2003). In addition, Woo and Reeves (2007) reported that not all interactions are meaningful. Only when the interaction has a direct influence on the learners’ intellectual growth can we say the interaction is meaningful (Hirumi 2002; Vrasidas & McIsaac 1999). Therefore, if interaction is to take place, and if that interaction is to be meaningful, that interaction needs to be supported if it is to be relevant for teaching and learning. In view of that, this research offers the following definition for supporting discourse; to encourage the meaningful interchange of thoughts, feelings and ideas for learning.

The Role of Technology-Mediated Communication

Considering technology-mediated communication is the hallmark of ICT-supported learning because it allows teachers and learners to structure dialogue much like how educational transactions develop in traditional classrooms (Garrison & Shale 1990), for the purpose of this research TMC is used as the medium for supporting discourse.
2.2 The Context for Supporting Discourse

As schools and teachers look towards integrating systems of ICT-supported learning into their classroom practice, Design and Technology (D&T) education continues to be recognised as a pedagogically rich environment to investigate both ICT-supported learning (Karakaya & Şenyapılı 2008; McCormick 2004) and collaborative settings (Drain 2010; Hennessy & Murphy 1999; Hong, Yu & Chen 2011; Rowell 2002). Further, the CoI model follows a constructivist-collaborative perspective (Garrison et al. 2000) that is conducive to the pedagogy of design-based education (Barber 2011).

D&T education has always faced the challenge of keeping up with emerging ICT. The history of D&T curricula is dotted with changes to subject content, influenced by the emergence of new technologies, from the development of the microprocessor to the growth of computer-aided design (CAD), D&T based education has tweaked and changed the content of syllabi to incorporate these elements (McGarr 2011). These changes reflect the traditional vocational nature of D&T education where preparation for the specific sectors of industry and business was a high priority. Owen-Jackson (2000) noted that from their inception, all D&T based subjects in second level education were “concerned only with [the] passing on to pupils traditional knowledge and skills [where] pupils were required only to learn the knowledge, not to understand it, and to copy and practise the making skills” (p. 11). The suite of D&T subjects in Irish second level education have recently undergone considerable reform (McGarr 2011). These changes mark a shift from the traditional focus of the subjects, aimed at developing craft skills and technical competence, to one that focuses on the development of transferrable knowledge, skills and attitudes. This shift mirrors an international move “from the transmission of facts or the demonstration of skills towards the development of active, autonomous learners” (Dow 2006, p. 309), and to “encourage the active involvement of pupils in authentic and meaningful learning experiences” (Dow 2006, p. 307) through the integration of more collaborative practices. Such approaches place a premium on problem solving, critical thinking, teamwork skills and creativity. In this context, the role of D&T education is not to pass on a set of technological skills transmitted in a behaviourist mode (Dakers 2005) but to create experiences where pupils engage as autonomous learners, solving real-world problems on their own and in collaboration with others.
2.2.1 Design and Technology Education

In Ireland, second level education is classified into the junior cycle and senior cycle. D&T education is provided through four subjects at the junior and senior cycle level. In the junior cycle, D&T education is provided through the subjects of Technology, Materials Technology (Wood), Metalwork, and Technical Graphics. Within the senior cycle, D&T education is provided through the subjects of Technology, Construction Studies, Engineering Technology, and Design and Communication Graphics, thereby providing progression from the junior cycle. As reported by, Carty and Phelan (2006) the aims of D&T education within the Irish educational system cannot be ascertained from specific subject aims, but from a more holistic view of all technology subjects within the curriculum. The aims listed below are extracted from the NCCA Consultation Document (2003) on D&T education at junior cycle level:

- To contribute to a balanced education, giving pupils a broad and challenging experience that will enable them to acquire a body of knowledge, understanding, cognitive and manipulative skills, and competencies, and so preparing them as technologically literate and creative participants in society
- To encourage and enable pupils to integrate such knowledge and skills, together with the qualities of co-operative inquiry and reflective thought, in developing creative solutions to technological problems and needs, using appropriate materials, equipment and resources to design, manufacture and produce artefacts and systems, with due regard for issues of health and safety
- To facilitate the development of a range of social and communication skills which will encourage and enable pupils to express their creativity in a practical and imaginative way and in a variety of forms, including verbal, graphic and model, and involving the selection and use of appropriate media
- To provide a context for pupils to explore and appreciate the impact of past, present and future technologies on their economy, society, and environment

These are important educational outcomes which contribute significantly to the provision of a broad and balanced curriculum and illustrate why participation within D&T education represents a valuable educational experience. In a syllabus document for D&T education at senior cycle level, the NCCA outlined the following statement:
Technology education is an essential component of the curriculum. In a world where encounters with a wide range of technologies are part of the daily life experience of all people at work or at leisure, students should be equipped to face these encounters with the confidence which comes from learning about, through and with a range of technologies. It is equally important that they gain an appreciation and understanding of the complex interface between technology and society. As citizens they should have the capacity to enter discussion on, and make personal judgements on, issues related to the impact of technology on their own lives, on society, and on the environment. Through technology education students grow in competence, grow in confidence, become more enterprising and are empowered in terms of their ability to control elements of the physical environment (2007, p. 2).

Therefore, as suggested by the NCCA (2007), D&T is a distinct form of creative activity where pupils interact with their environments, using appropriate materials and processes in response to needs, wants and opportunities. It integrates real-world problem solving and practical skills in the production of useful artefacts and systems.

More specifically, the value of technology education comes from the use of the wide variety of abilities required to produce a drawing or make an artefact, leading to a sense of competence and a feeling of personal empowerment. The acquisition of manipulative skills is an important component of this sense of competence and can help to give students a feeling of control of their physical environment. In a rapidly changing global society, students need to appreciate that technological capability is necessary and relevant for all aspects of living and working. Many subjects can contribute to the development of a technological capability. However, the technology subjects, which incorporate the principles of design and realisation in a creative manner, are central to this development (2007, p. 2).

Therefore, capability in D&T includes: the understanding of appropriate concepts and processes, skills of design and realisation, the ability to apply knowledge and skills by thinking and acting confidently, imaginatively, and with sensitivity, and the ability to evaluate technological artefacts and systems critically and constructively.
For this reason, D&T and the ‘design process’, is well placed within the curriculum as the educational context for supporting discourse between the teachers and pupils. The “concept of the design process is now well established” (Mawson 2003, p. 119), as a structure for contemporary D&T education, and progressing the implementation of design-based activity is dependent on teachers embracing pedagogies that are based on what is now understood about pupils technological capability and practice. According to Williams (2009), the design process is embedded within the personal and social context of the pupil. Describing the role of knowledge in this process Williams notes that “the domain of knowledge as a separate entity is irrelevant; the relevance of knowledge is determined by its application to the technological issue at hand. So the skill does not lie in the recall and application of knowledge, but in the decisions about, and sourcing of, what knowledge is relevant”, (2009, pp. 248-249). However, this process can be rather challenging for pupils and requires appropriate support and interventions from teachers and peers for this process to be effective. Although, ICT has the potential to aid both teachers and pupils within this process, care must be taken to ensure the approach facilitates rather than dictates this process.

### 2.2.2 Restricting the Process of Design

Thus far, this research has presented D&T as a rich context for supporting discourse. However, D&T education and the design process are not without their restrictions. Therefore, with clear objectives for D&T and an understanding of the role of design in the context of contemporary education, this investigation focuses on assessment, and the influence that assessment may have on the process of teaching and learning. The standard approach to completing a typical design-based assignment as is normal practice in D&T education requires the production of a paper-based A3 portfolio which contains a limited amount of pages and candidates are instructed to follow a set of predefined outputs in strict chronological order to achieve maximum grades. Figure 2.1 shows a simple model of the design process as was first published by the State Examinations Commission in 2008, and included in ‘The Design Briefs for the Certificate Examinations’ given to pupils each year, with the following statement: “It is recommended that you follow the sequence of such a design process” (2008, p. 4). This model is seen as the basis for all design-based activities undertaken by pupils. As a result of this, designing is seen as a means to an end rather than an end in itself.
Mike Ive (ex HMI Inspector and subject adviser for D&T), has described the work put into some design portfolios as “neat nonsense” (cited in Barlex 2007, p. 53), referring to the way in which presentation is emphasised over content with pupils spending precious lesson time drawing and colouring-in boarders on their A3 papers. Parker (2003) echoed this in his perspective view on the issues of design portfolios:

To a large extent, the tail wags the dog. Teachers are reluctant to change their practices when they have established strategies to ensure their A* to C grades each year. [The examinations] coursework assessment procedures discourage teachers from breaking the mould. They seem more typically to reward those students who can jump through the assessment hoops rather than encouraging those who are able to show real flare and imagination. The development of creativity in students, the opportunity for them to propose imaginative solutions, take risks, be intuitive, inventive, and innovative in their work, has been side-lined by an approach which has become far too mechanistic, (p. 7).
Kimbell (2004) describes the situation with regard to assessment in D&T as being “widely regarded as having become formulaic, routinised and predictable” (p. 100). Rutland and Barlex (2008) have since argued that there is a shortage of teachers in D&T who aim to foster pupils’ creativity because it is not easy to be such a teacher. This is because creativity involves discovery, risk taking, pushing the limits, and taking a step into the unknown, “this is a serious business - dangerous business and when you challenge pupils to be creative, you lose control” (Torrance 1995, p. 107). In a report by Robinson (1999, p. 102), creative teaching was defined in two ways, first teaching creatively and second teaching for creativity. Teaching creatively in the report is interpreted as when teachers use imaginative approaches in an attempt to make learning more interesting, exciting and effective. This can be described as merely ‘good practice’, as the teacher are themselves being creative and taking the initiative to develop materials and approaches that can interest and motivate pupils. Whereas, in teaching for creativity, the focus is on approaches of teaching that are specifically intended to foster and enhance pupils’ creative thinking or behaviour. Accordingly, since there is a standing agreement that assessment in D&T should be more about assessing pupils thinking, as well as their doing (Owen-Jackson, 2013), it’s helpful to first understand the nature of creative or ‘designerly’ thinking in D&T.

2.2.3 Designerly Thinking and Discourse

Kelly, Kimbell, Patterson, Saxton and Stables (1987) gave form to their ideas about designing and expressed them through a model which illustrated thought and action as being an iterative and interactive form of discourse between the mind and hand. This model encapsulates a way of structuring the design process that is involved in taking an idea from its first hazy conception through to becoming a working reality.

In articulating their views, Kelly et al. (1987) were explicitly avoiding what, at the time, were more common linear or cyclical models of design. They believed that any design process was driven by the development of the idea and taking an initial spark of a hazy conception forward, involved a range of sub-processes such as making judgements, finding out new information, articulating the form of the idea and so on. However, they believed that these sub-processes could not be prescribed in advance; they need to be engaged in responsively, led by the demands in the task and the idea.
Kimbell et al. (1991), in their work in the Assessment of Performance Unit (APU), developed this early model of designing into the iterative model of mind and hand – inside and outside the head, which he refers to as ‘thought in action’ (see Figure 2.2).

**Interaction of Mind and Hand**

<table>
<thead>
<tr>
<th>Thinking (inside the head)</th>
<th>Doing (in real world)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start with initial (hazy) idea</td>
<td>Talk to others, make drawings, sketches, notes, graphs of idea</td>
</tr>
<tr>
<td>Explore new idea, enhance the idea</td>
<td>Make a rough model to represent an idea or prediction</td>
</tr>
<tr>
<td>Clarify and validate idea</td>
<td>Make a prototype and test it in several situations</td>
</tr>
<tr>
<td>Critically appraise idea</td>
<td>Potential for more developed solutions</td>
</tr>
<tr>
<td>Potential for more developed thinking</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 2.2 The Interaction of Mind and Hand (Kimbell et al. 1991)**

In articulating design in this way Kimbell et al. (1991) were also giving form to the view of designerly thinking – that this too is idea-driven and progresses through an iteration between thought in action. In making a link between designing and designerly thinking (Kimbell et al., 1991) was stepping into the territory of cognition and learning, that by engaging with designerly thinking promoted by the responsive, iterative view of design has immense potential for learning. Oxman (2001) presents a similar perspective in her plea for a shift in design education (in her case at higher education level) away from emphasising the products of designing and towards the cognitive properties of design. As in Kimbell’s model, she stresses the importance of visual representation and reasoning and not only identifies the critical nature of imaging and cognitive modelling for developing designerly thinking but makes the link (with reference to Papert 1991), to knowledge and designerly ways of knowing:
Through constructing representations of design thinking the student [or the pupil] gradually becomes richer in his ability to think in designerly ways. This contributes to an understanding of cognitive processes, which are characteristics of design, or as Papert has stated, this form of education contributes to ‘knowing rather than to knowledge’, (Oxman 2001, p. 282).

However, designing and designerly thinking is more than just a cognitive process. The nature of designing in the D&T classroom is a socially mediated activity which draws on pupil-pupil and pupil-teacher interactions (Hamilton 2003, 2004; Hennessy & Murphy 1999; Murphy & Hennessy 2001). As such it moves beyond cognitive constructivism to social constructivism which places language and interaction at the heart of the learning process (Trebell 2007). Murphy and Hennessy (2001) have shown that pupils of D&T seek opportunities to interact with peers even when these are not made explicit by the pedagogic stance adopted by the teacher. This reflects the work of Vygotsky (1978) who believed “learning awakens a variety of internal developmental processes that are able to operate only when the child is interacting with people in his environment and in cooperation with peers” (p. 90). Based on Vygotsky’s work Trebell (2007) argues that the development of effective design-based activity is seen as occurring first within the shared activities of individuals, particularly between young and mature designers, i.e., the pupil and their teacher. In turn this is transformed into inner understanding and further into designerly thinking.

In the context of D&T this would include supporting discourse through the use of scaffolded interactions where the act of designing becomes the focus of conversation with the interactions being seen as a tool to develop a mutually appropriated concept, or as Schön (1983) puts it “a conversation with the materials of a situation” (p.78), during the iterative and interactive development of the design process or design idea. Hence, the design process is unified through the dialectical synthesis of interactions, frequently referred to as the zone of proximal development (ZPD) (Vygotsky 1978). For instance, Trebell (2007) has suggested that when designing collaboratively, both verbal and visual discourse between individuals, particularly inexperienced and experienced speakers, is transformed into inner speech and further into designerly thinking and external designerly activity thus producing, (i.e. building on Vygotsky’s ZPD theory), what could be termed as the zone of designerly proximal development.
As outlined in the previous section, traditional, summative assessment is restricting the design process and is therefore restricting its potential for supporting discourse. However, considering D&T and the design process follow a constructivist approach, and the CoI model follows a constructivist-collaborative perspective (Garrison et al. 2000) which is conducive to the pedagogy of design-based education (Barber 2011), to support a constructivist approach, formative assessment is required (Wood 1987).

The aim of formative assessment is to provide feedback to pupils and allow teachers to modify learning activities to meet pupils’ emerging needs (Black & Wiliam 1998). Black (1998) writes of the necessity for teachers to be able to make decisions on what to assess and how to interpret pupils work based on their evidence of learning: “the practice of formative assessment has to be informed by a model that is quite detailed, in that it has to provide some guidance about the ways in which a pupil might progress in learning, linked to a clear conception of the curriculum and its learning goals” (Black 1998, p. 26). Therefore, feedback is a key element to effective formative assessment and is usually defined in terms of information that provides the learner the opportunity to see how well they are doing or have done, (Sadler 1989). Sadler (1989) makes the point that the more complex the learning situation, the more sophisticated the feedback needs to be. Hence, the quality of feedback is essential in supporting and enhancing learning. Pupils have been shown to benefit from feedback that identifies both the strengths and weaknesses of their work, enabling them to take control of their own learning. In D&T, where progression in learning may be thought to consist of dealing with a greater number and a more complex array of variables, the capacity for both teachers and pupils to provide sophisticated feedback is critical. In order for this to happen successfully within D&T education, a common or shared language in which appropriate learning processes and progressions can be discussed is then required (Moreland & Jones 2000). This language needs to relate to concrete examples of effective teaching and learning in second level, to gain practical effect.

Though difficult to provide evidence of the iterative and interactive design process, in recent years there has been a growing interest and discussion in schools around the potential of ICT for more formative “e-assessment practices” (McLaren 2012, p. 2). However, to formatively assess the teacher-pupil and pupil-pupil interactions which define the nature of D&T education requires a novel approach in the addition of ICT.
2.2.4 Capturing the Process of Design

In 2002, the Technology Education Research Unit (TERU), Goldsmiths University of London, led by Professor Richard Kimbell launched the ‘Assessing Design Innovation’ project. This project arose through the growing awareness (within the Department for Education and Skills and elsewhere) that assessment processes were suppressing creative performance within D&T education (Kimbell & Stables 2007). At the same time, formative assessment had become a major concern of educators (Kimbell 2012) as it placed the teacher at the heart of the assessment process and presented them with large amounts of personalised learning information to manage (Black & Wiliam 2003). Within this emerging field, Kimbell, Bain, Miller, Stables, Wheeler and Wright (2004) saw much value in exploring the use of digital systems to support teachers and pupils. In the course of their project, Kimbell et al. (2004) explored the potential, both in assessment and development terms, of the immediacy of digital photography for capturing a ‘photo-storyline’ of the evidence of learning.

The success of capturing pupil evidence in a digital format encouraged the research group to investigate the power of other digital approaches. This potential led directly to the e-scape (e-solutions for creative assessment in portfolio environments) project.

The e-scape project was intended to develop systems and approaches that enabled pupils to build real-time e-portfolios of their performance within D&T using digital technologies, and to facilitate the e-assessment of those portfolios (Kimbell 2012). Being aware of the problems of mixing computers with D&T learning environments, Kimbell (2012) believed that at the leading edge of this digital technology would be peripheral, back-pocket technologies such as digital cameras, digital pens, personal digital assistants, and mobile phones, rather than desktop or even laptop machines. This is third-generation technology that can be used directly in D&T environments alongside other designing resources (Kimbell & Stables 2007). This was a concern from the outset of e-scape; to ensure that any digital systems introduced in the design activity should operate as an enhancement to the activity, rather than as a distraction.

This ubiquitous method opened up new ways of capturing data to evidence learning including audio recordings of pupils immediate thoughts and reflections on how they were getting on, live video footage of working prototypes, and more (Kimbell 2012).
Kimbell (2012) outlines the importance of defining the nature of e-portfolios in D&T and describes it as the mix of assessment portfolios, learning portfolios and working portfolios. In this form, the e-portfolio is transformed into an entity that is integrated into and grows dynamically with the project and in the process it shapes and pushes forward the project. Kimbell (2012) describes this process as a ‘dialogue’, where the pupil is having a conversation with themselves through the medium of the portfolio. Kimbell (2012) suggests that these interactions and ideas may arise from “procedural prompts” (p. 127), that are deliberately located in the activity to support discourse. Looking in on this form of e-portfolio is one step closer to looking inside the head of the pupil, revealing more of what they are thinking and feeling, and experiencing in the live real-time struggle to resolve the issues that surround and make up the task.

While the ‘authenticity’ of the digital portfolios developed as part of the e-scape projects, have appeal to teachers, pupils and assessors as being the actual record of pupil-content interaction (Williams & Kimbell 2012), they fail to support the pupil-pupil and pupil-teacher interaction which defines communication in ICT-supported learning (Moore 1989) and the social nature of design in D&T education (Hamilton 2003, 2004; Hennessy & Murphy 1999; Murphy & Hennessy 2001). Although it has become common practice for pupils of D&T to take part in classroom activities either in pairs or small groups, the complex and multidisciplinary nature of design-based activity calls for more intensive collaboration (Seitamaa-Hakkarainen, Kangas, Raunio & Hakkarainen 2012), and henceforth the assessment of this collaboration. Collaboration here is defined as a process in which pupils actively work together in creating and sharing their design ideas, deliberately making joint decisions and producing shared design objects, constructing and modifying their design solutions, as well as evaluating their process through discourse (Hennessy & Murphy 1999). Though difficult to provide evidence of, this approach necessitates a practice of discourse that values both the teachers and pupils voice as authentication of both collaborative problem solving and interdependency in performance assessment while maintaining a focus on the overall design solution. Subsequently, in an effort to document the complex and fundamentally non-linear nature of design-based activity, the use of collaborative settings (Drain 2010; Hennessy & Murphy 1999; Hong et al. 2011; Rowell 2002) as well as systems of ICT-supported learning within the area of D&T education has since increased (Karakaya & Şenyapılı 2008; McCormick 2004).
In design education collaborative settings and systems of ICT have been widely used (Craig & Zimring 2000; Gül, Wang, Bülbü, Çağdaş & Tong 2008; Rummel, Spada, Hermann, Caspar & Schornstein 2002; Tokman, Tong, Yamacli & Cagdas 2006) in particular in the form of online design studios. Broadfoot and Bennett (2003) define such online design studios as web-based studios, which are networked studios, distributed across both space and time, such that the participants of an online design studio maybe in different locations handling design communications via technology. The emphasis is placed on human-to-human interactions as common understandings are negotiated and developed across differences of knowledge, skills and attitudes.

Hence, while e-portfolios are used for assessing evidence of design-based activity, on their own, they are substandard as they cannot be used for supporting discourse. Accordingly, schools and teachers are looking towards recent advancements in ICT to support the iterative design process between teachers and pupils through discourse and provide effective feedback through formative assessment to enhance the process.

### 2.2.5 Potential for Supporting Discourse

This research acknowledges the potential opportunities afforded by D&T education for supporting discourse in design-based activity in second level education because:

- Discourse is understood as the interchange of thoughts, feelings or ideas, and; Design is an iterative and interactive form of discourse which encapsulates a way of structuring the processes that are involved in taking a thought, feeling or idea from its initial hazy conception through to becoming a working reality
- D&T education has previous experience with transforming ICT into an entity that is integrated into and grows dynamically with the process of design and through discourse it shapes and moves this process forward, where pupils are having conversations with themselves and others through the medium of ICT
- The CoI model and the related processes follow a constructivist-collaborative perspective conducive to the pedagogical approach of design-based education

Thus, in the context of D&T, this research focuses on the nature of ICT in education, mainly, the design of ICT-supported learning environments for supporting discourse.
2.3 The Environment for Supporting Discourse

The development of ICT has placed continuous pressure on schools and classrooms to modernise and profit from the educational potential of technology (McGarr 2009). However, a comparative analysis of the digital skills that pupils in schools acquired, and the learning environments designed to develop these skills, shows that in reality our schools lag rather considerably behind the promise of technology (OECD 2015). Nevertheless, the debate about the use and justification of ICT in schools has been replaced by a discourse of inevitability, where schools of the future are presented as ICT rich sites of learning. Yet despite this faith in technology there appears to be a vagueness about what role ICT will actually play and more specifically what way its inclusion will enhance the effectiveness of teaching and learning. One reason for such vagueness could be a result of the pace of technological change where a lack of specificity future-proofs policy statements, prolonging their shelf-life while enabling them to embrace the not yet developed technologies and future pedagogies that may come into fashion (McGarr & McDonagh 2015). However, it could be argued that another reason for such vagueness lies in the unquestioned acceptance of technology. The ‘space’ created within this inevitable discourse enables schools and teachers to integrate technology without any guiding epistemological or pedagogical framework. However, we have not yet become good enough at the kind of pedagogies that make the most of technology; and adding 21st century technologies to 20th century teaching practices will just dilute the effectiveness of the teaching and learning (OECD 2015).

As long as technology and the internet continue to have a central role in our personal and professional lives, those pupils who have not acquired the basic skills in reading, writing and navigating through a digital landscape will find themselves unable to participate within the economic, social and cultural life around them (OECD 2015). Amidst the decidedly mixed messages that are drawn from the PISA data, which suggests that a limited use of ICT at school is better than not using technology at all, using them more intensively is associated with significantly ineffective learning. However, technology is linked with better learning in some contexts, such as when ICT extends teaching and learning and enhances classroom practice (OECD 2015). Accordingly, if pupils are to benefit from the educational potential of technology, teachers need a pedagogical model for enhancing practice in second level education.
2.3.1 The Nature of Technology in Education

There is little doubt that technology in education has captured the imagination of the wider public. Technology in schools, be it laptops, tablets or desktop computers, is seen as a sign of innovation and progress. McGarr and McDonagh (2015) noted that images of good schools were closely associated with teachers with laptops and pupils clustered excitedly around pods of computers. Such is the extent of this unquestioned faith in the technology that a culture of inevitability has developed around the use of ICT in schools. This inevitability manifests itself in different ways.

Firstly, it can prominently be seen in the emphasis given to hardware acquisition. Acquiring significant levels of ICT infrastructure is seen as a vital aim of schools and educational institutions in general. International comparisons by the Programme for International Student Assessment (PISA) of pupils per computer ratios or comparisons of overall expenditure on ICT infrastructure are evidence of this focus. Further evidence of this emphasis on hardware acquisition is made apparent by the attention given to technology rich schools that possess higher than average ICT resources (McGarr & McDonagh 2015). These schools are often presented as models of ‘best practice’ and as schools that have ‘progressed’ further than others. These schools are further given significant attention in local and national media which cements the belief in the wider public that ‘progressive’ and ‘modern’ schools are ICT rich sites of learning. The attention on schools with very high levels of ICT resources also plays on the anxieties of parents concerned that their children will be ‘left behind’ in the competitive educational marketplace, as investing in computers is, so parents are told, a way of investing in your children’s future (Ferneding 2003).

The importance of this type of ‘literacy’ has raised the issue of the digital divide – a concern that not all pupils will have appropriate access to this technology and therefore will be disadvantaged. It is now seen as critical that schools begin to address these skills to ensure that no pupil is left behind. As Davis et al. (1997) claim, “one of the most important challenges to an educational system is to empower the young with the intellectual tools of the culture” (p. 16). The emergence of a possible digital divide sparked governments to address the problem through school-based interventions which have led to many high profile initiatives launched towards the end of the 20th century. Ireland was no exception and in 1998 began investing in ICT infrastructure for schools.
However, the extent to which this has addressed the digital divide is unknown. Mulkeen (2003) importantly highlights that technological literacy does not simply entail access to computers but that “the real digital divide may not be between those who have used a computer and those who have not, but between those with different types of ICT experience” (p. 17). Defining the digital divide is therefore problematic and goes beyond distinguishing between those with access to technology and those who don’t. Hawkins and Oblinge (2006) discuss the notion of the second-level digital divide and this is where the hidden and very real divide lies. This digital divide is caused by several issues: age of the machine, connectivity, online skills, independence and freedom of access, and computer-use support. The definition of the digital divide must therefore include all of these other issues. It can also be argued that this second-level digital divide also encompasses the type of use of the technology as indicated by Mulkeen (2003) where a school advocates some use of the available technologies but in a very superficial manner; in comparison with a school ICT policy that champions the meaningful and constructive integration of technology into their teaching and learning. ICT policy in Ireland reflects the technocentric optimism with the now familiar concerns about economic competitiveness in global markets regarding equipping pupils with the skills of the future (DES 2009). The concerns regarding ICT are further evident within the literature where countries with poorer ICT skills might not form part of the ‘knowledge economy’ (Egea 2014) and an education without ICT represents a deprived learning context (Kompf 2005).

However, a significant omission from this argument is any detail in relation to the actual nature of ICT usage in schools. This is perhaps based on the belief that the presence of the technology in the classroom is automatically a positive development limited only by the financial capacity of the system to purchase more technology. Yet this blind faith in the educational merits of the technology is questionable. While “research within the Irish educational system into the nature of ICT usage is sparse, evidence does point to limited ICT usage and where presented is quite different from the rhetoric painted within the national psyche” (McGarr & McDonagh 2015, p. 2). Research on the nature of teaching and learning within the Irish context suggests that technology in the classroom remains used primarily to support traditional teacher-centred approaches (DES 2008; Judge 2013), and misaligned with the constructivist image presented in much of the optimistic accounts of ICT usage, (Hammond 2014).
2.3.2 The Use of Technology in Classrooms

To understand the context of this study it is important to highlight the aspects that have shaped how ICT is used and perceived in schools and what are the prevailing pedagogical approaches in classrooms as both of these issues significantly impact and determine the successful integration of any ICT initiative across the curriculum. Computer use in Ireland has had a long history. However the rationale for its use in schools has changed over the decades. Early justifications for its use were motivated by an early group of pioneers, coming mainly from a mathematics background and they saw the computer as a machine to be studied (McGarr 2009). This influenced early computer usage where pupils learned about the operation of the computer and developed programming knowledge. However, throughout the 1980s computer use in schools appeared to organically develop into a separate subject that focused on basic ICT skills such as the use of word processing, spreadsheets and other standard applications. Rather than moving to a specialist area of study, ICT emerged largely as a standalone subject (Drury 1995; McKenna, Brady, Bates, Brick & Drury 1993).

The launch of the Schools IT2000 initiative, the first large scale attempt to integrate ICT across the curriculum in 1998, also had a strong focus on the need to equip all pupils with basic ICT skills. This was particularly important in a system that did not have a compulsory ICT experience for pupils in second level education. Therefore when one looks at the past three decades of ICT usage in schools it is evident that the rationale for their use is strongly based on what could be described as a social rationale that, as reported in 2012 by the Department of Education and Skills (DES), is a focus on ensuring all pupils have a basic level of ICT competency and literacy. Ultimately, it remains in general a subject to be taught. This is done mainly though the provision of skills courses aimed at developing competence in basic software applications. There are some pockets of ICT integration but this appears to be quite limited (DES 2008), and the predominant use of ICT across the curriculum appears to be visual aids for teachers where presentation software, e.g. PowerPoint, is used.

In terms of the Irish context, a study on the historical development of ICT within second level education (McGarr 2009) highlighted significant trends between such initiatives and the resulting ICT use in schools. It was found that despite the efforts
of ICT initiatives little influence on teachers’ practice had occurred. Teachers’ ICT use had in most cases developed independently of the efforts of the ICT initiatives. This is not surprising as any form of change leads to intensification of teachers work by adding burdens to a job that is already “excessively demanding” (Hargreaves & Evans 1997, p. 4). Therefore, there is no major incentive for teachers to attempt different teaching strategies, including the use of ICT. Although, many teachers are interested in adopting change in their classrooms and “will do so under the right conditions” (Fullan 2007, p. 60), this is undermined by the current assessment system which consists of a ‘high-stakes’ end of school examination, known as the leaving certificate, which determines access to higher education based solely on the grade achieved by pupils in this examination. This type of assessment combined with a crowded curriculum results in a premium being placed on content coverage that militates against the meaningful integration of ICT within current syllabi and negates constructivist approaches for teaching (Donnelly, McGarr & O’Reilly 2011). Therefore, while the current view of ICT in schools is that it has great potential for presenting information, its use as a pedagogical approach for effective teaching and learning seems to be undervalued due to external pressures of terminal assessments.

Hence, the second aspect of the Irish context pertinent to this study is the prevailing nature of teaching and learning within second level education. Classroom teaching practices in Ireland have long been criticised for their teacher-centred nature and the didactic nature of the learning experience (Marcus-Quinn & McGarr 2013). As far back as 1991 the OECD found that teaching and curriculum were largely determined by examination requirements and that there was a strong emphasis on “a didactic approach” (OECD 1991, p. 55). Later studies in the same decade by Callan (1997) and Mackey (1998) further reported a largely teacher-centred approach to learning. Lyons, Lynch, Close, Sheerin and Boland (2003) revealed similar results reporting that “classes were strongly teacher directed, with teachers generally using a didactic approach to the presentation of material ... [with a lack of] student participation in the organisation of their own learning” (p. 147). A recent Teaching and Learning International Study (TALIS) report on Ireland, published in 2009, supports these earlier findings reporting that “teachers in Ireland were somewhat less supportive of constructivist beliefs, and somewhat more supportive of direct transmission beliefs” than teachers in all five comparison countries (Shiel, Perkins & Gilleece 2009, p. 6).
The critical issue here is that teachers’ pedagogy, for whatever reason, seems to align more with a transmission model and therefore their use of ICT in the classroom is limited to presenting information and not developing knowledge and understanding. This is problematic within D&T education where the design-based nature of the subject requires a more constructivist approach to knowledge for it to be meaningful. Therefore, to support the purposeful integration of ICT for enhancing practice, technological applications need to be grounded in sound pedagogical approaches that take cognisance of disciplines requirements and views ICT as a medium for learning.

2.3.3 Barriers to Integrating Technology

Many potential issues arise in attempts to not just implement ICT software into second level education but also in ensuring that once implemented the effective pedagogical use of these tools occurs (Donnelly et al. 2011). Provenzo, Brett and McCloskey (1999) argue that there are a number of questions teachers using ICT should ask, these include: How does technology impact the ecology of the classroom and the school? How does it enhance learning? How does it enhance instruction? This view of ICT as a catalyst for pedagogical change fails to consider the alternative perspective, that is, rather than asking how ICT enhances pedagogy, we should perhaps consider how pedagogy enhances ICT (Loveless, DeVoogd & Bohlin 2001).

To date, little evidence has shown that the introduction of ICT enhances pedagogy (McGarr 2009). Higgins and Moseley (2001) note that existing approaches to teaching and learning have a powerful inertia and that schools tend to assimilate, rather than accommodate, new approaches to the use of ICT. Levin and Wadmany (2005) argue that despite the changes in society as a result of ICT it is not widely integrated into the educational system and, where it is present, there is no evidence that it has affected the teaching approaches. Hayes (2007) observes that although research into the use of ICT in education is into its third decade, there is still “a pressing need to better understand how computer-based technologies are influencing learning opportunities” (p. 385). There are many reasons given for the low levels of impact in the classroom. Many of the most common factors influencing the level of impact include: inadequate infrastructure, limited access to the technology, lack of training and personal expertise, weak technical support, poor planning and teacher
beliefs (Baek, Jung & Kim 2008; Ringstaff & Kelley 2002). Ertmer (1999) categorises these barriers into two levels; first and second order barriers. First order barriers, are those which include equipment, training, and support, are the most visible and easiest to remove. Ertmer (1999) noted the majority of early integration efforts focused on addressing these “laundry lists” (p. 51). Second order barriers on the other hand are more difficult to address as they are “barriers that interfere or impede fundamental change” (p. 51). These types of barriers are rooted in teachers underlying beliefs and include beliefs about teacher-learner roles, classroom practices, teaching methods, organisational and management styles and assessment.

Zhao, Pugh, Sheldon and Byers (2002) presented an expanded model of barriers to the integration of technology. They identified 11 salient factors that influence the success of technological innovations in classrooms. These factors were placed within three interactive domains of the teacher, the innovation, and the context. The factors within the first domain, the teacher domain, will be discussed in detail in a later paragraph. The factors in the second domain, the innovation domain, revolved around two areas; distance and dependence. The first area, distance, referred to the deviation of the innovation from the status quo. This encompassed three sub-areas within distance; distance from the existing school culture, distance from existing practice and distance from available technological resources. The second area, dependence, referred to how much an innovation relied on other people or resources, in particular people or resources that are beyond the innovator’s immediate control.

The third domain, the context, had three aspects that were of key importance to the impact of an innovation. These were the human infrastructure, the technological infrastructure and the social support. The first aspect, human infrastructure, refers to organisational preparation to support technology integration in the classroom. The second aspect, the technological infrastructure, refers to how much resources are currently available in a school to meet the needs of the innovation. The third aspect, the social support, refers to the extent to which peers support or discourage the innovators. Various studies on the implementation of ICT innovations within schools highlight factors of success or failure that can often be related to Zhao et al.’s (2002) three interactive domains (Brinkerhoff 2006; Chen, Looi & Chen 2009; Lowther, Inan, Strahl & Ross 2008; Tondeur, Devos, Van Houtte, van Braak & Valcke 2009).
When looking at factors that affect technology use the teacher is naturally the first person one can look to (Zhao et al. 2002). Fullan (2007) echoes this stating that educational change is based on “what teachers do and think - it’s as simple and as complex as that” (p. 129). This is not to dismiss other educational stakeholders or barriers to integrating technology but to highlight that changes within the classroom learning experience ultimately reside with teachers (Donnelly et al. 2011). In the teacher domain, Zhao et al. (2002) explained three factors associated with the teacher that impacted technology integration within classrooms; technology proficiency, pedagogical compatibility and social awareness. The first factor refers to not just knowledge of the technology but also the enabling conditions. The second factor refers to the compatibility of the teacher’s pedagogical beliefs and the technology being used. The third factor highlights the significance in the ability of a teacher to negotiate the social facets of the school culture. The discussion is now going to expand on the second factor mentioned, the compatibility of teacher’s pedagogical beliefs and the technology being used. Since it is clear that the adoption of any new technology depends on the values and beliefs of teachers about the importance of the ICT for learning (Webb & Cox 2004), if teachers’ use of ICT is to change then their beliefs about the ICT have to change (Russell, Bebell, O'Dwyer & O'Connor 2003).

### 2.3.4 A Precursor for Enhancing Practice

Webb (2005) explains ICT from the point of view of the affordances they provide to support learning and the need for teachers and curriculum developers to see how these affordances could be used to support other improvements such as social and cognitive development, formative assessment and new curricula. Baggott la Velle, Wishart, McFarlane, Brawn and John (2007) echo the importance of ICT as a tool that allows teachers to transform the learning in their classrooms as it aids them in the development of new Pedagogical Content Knowledge (PCK) domains (Shulman 1987), i.e., new ways to make concepts understandable for pupils (Shulman 1986). Mishra and Koehler (2006) present an expanded model to Shulman’s PCK that encompasses technology-related knowledge and they refer to this as Technological, Pedagogical [and] Content Knowledge (TPCK or commonly referred to as TPACK). This model highlights the important role ICT plays in enhancing teachers’ PCK and the distinct types of knowledge underpinning teachers’ ICT use. The three main
knowledge areas of pedagogy, technology and content, derive four more interrelated types of knowledge i.e. PCK, Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK) and TPACK (see Figure 2.3). From a knowledge of how technological affordances can support other improvements combined with pedagogical content knowledge, TPACK and knowledge of learners, teachers can work with pupils to develop an ICT-supported learning environment that provide appropriate opportunities for enhanced classroom practice (Webb 2005). Hence, this research argues that TPACK is a precursor for enhancing practice, taking cognisance of the discipline requirements and viewing ICT as a medium for learning. However, as shown in Figure 2.3, an ICT-supported learning environment involving both pedagogical and technological knowledge will require an integrated approach.

Figure 2.3 TPACK Model (Mishra & Koehler 2006)
An integrated approach towards ICT-supported learning environments is presaged by an initial recognition that both pedagogical and technological perspectives involve three convergent principles of design: the organisation of information, the facility for communication and some convergent mode of user interaction (Richards 2006). As previously mentioned, the tendency to use the acronym ICT instead of IT reflects the growing recognition that information is inevitably framed within the contexts and imperatives of communication; also, technology is more significantly a system of and for communication rather than an endless database or repository for information. Likewise, in education there is a growing recognition that ICT needs to be linked to discursive activities in social contexts and communities of learning (Richards 2006). A discursive, rather than dichotomous, view takes into account the relationship between the spatial function of information organisation and the temporal function (i.e. a continuum between asynchronous and synchronous modes) of communication in terms of human-human, computer-computer, and human-computer interaction. To the extent that if technology is the necessary condition and pedagogy is the sufficient process of ICT-supported learning, then the function of communication to not only support but to also contextualise teacher-pupil and pupil-pupil interactions precedes and supersedes those of information transmission within a constructivist perspective.

Therefore, in response to the vagueness about what role ICT will play in classrooms and specifically how technology will enhance the effectives of teaching and learning, the use of ICT should create an additional dimension for teaching and learning that goes beyond the traditional institutional, spatial or temporal boundaries of schooling. This is the kind of pedagogy that will make the most of technology and allow for the real contributions ICT can make to learning to be realised and exploited, not diluted. Hence, TPACK must be a precursor for such an ICT-supported learning environment to develop an integrated approach that surpasses old transmission models of learning.

2.3.5 A Space for Supporting Discourse

Laurillard (2002) notes how teachers have been under such pressure to meet growing assessment demands and teach larger numbers of pupils that they have been unable to go beyond traditional methods of teaching and how contemporary practice has not yet evolved sufficiently to keep pace with both what is needed and what ICT affords:
We have begun at last to play with digital technologies as a way of meeting the demands of the digital age, but with an approach still born of the transmission model. The academic community has not redefined what counts as ‘higher learning’ and therefore cannot draft the specification for how the new technology should do anything other than what learning technology has always done: transmit the [teacher’s] knowledge to the [pupil]. The academic world has called each new technological device – word processing, interactive video, hypertext, multimedia, the Web – into the service of the transmission model of learning. The potential of the technology to serve a different kind of learning cannot be exploited by an academic community that clings only to what it knows. […] There is no progress, therefore, in how we teach, despite what might be possible with the new technology, (p. 141).

Although over a decade old this statement is unfortunately very much true of today, and the reason our schools lag rather considerably behind the promise of technology. The integration of ICT in classrooms involves more than a ‘plug-and-play’ approach, and must go beyond the simple transmission or ‘downloading’ of information to a transactional model in support of constructivist and activity-based modes of learning.

Dewey (1938) proposed a transactional conception of activity-based education which describes the teaching and learning experience as a set of transactions “taking place between an individual and what, at the time, constitutes [their] environment” (p. 43). Dewey’s description not only fits neatly with the complex shifting of time and space that defines ICT but also emphasises the importance of interactions between the various people, content, and resources in an environment. For Dewey, interaction is the defining component of the educational process that occurs when pupils transform information passed on from another person and actively construct it into knowledge with personal meaning and value. Therefore, if we can exploit the communicative, interactive, and adaptive capabilities of ICT with an integrated approach then we can support different kinds of discourse between teachers and pupils, transforming the learning experience into one that fits better with the requirements of the digital age. However, Moore’s (1973) theory of transactional distance, which is distinguished from spatial or temporal distance as; the social and cognitive space that separates teachers from learners in the communication between them in an educational setting,
first needs to be considered if this research is to isolate the processes and conditions for supporting discourse between teachers and pupils in ICT-supported environments and to inform a pedagogical model for enhancing practice in second level education.

According to Moore (1991), transactional distance is pedagogical, not technological, and necessitates “special organisations and teaching procedures” (p. 3) made of three dimensions: structure, dialogue and learning (Moore 1990; Moore & Kearsley 1996), where structure is the design of the learning experience and communication medium, and dialogue is the internal or external communication between teachers and pupils. In Moore’s theory, the most distant transaction has low structure and low dialogue, while the least distant transaction has high structure and high dialogue. Therefore, if we are to reduce the social and cognitive space that separates teachers from learners in ICT-supported learning environments, we need a model for structuring dialogue. According to Moore (1990), the learning dimension must also be considered within ICT-supported learning environments and the amount of learner autonomy exercised. Moore claimed that models of ICT-supported learning that only considered variables of teaching (structure and dialogue) would be incomplete (Moore & Kearsley 1996). For example, even when a transaction is highly structured, the learners may decide for themselves whether the guidance and directions will be used and, if so, when, where, in what way, and to what extent. The praxis of this model then involves determining the correct mix of structure, dialogue and autonomy. Though, the exact nature of the interrelationships among structure, dialogue and autonomy is not clear, it must be considered in the design of a pedagogical model for supporting discourse.

Though Moore’s (1990) work is one of the most appealing and well known theories, macro-level theoretical work that goes beyond simply refining this promising theory is required (Moore & Kearsley 1996). In addition to the “infilling of the theoretical spaces” (Moore 1990, p. 14), the creation of a visual framework would go a long way to clarifying the structural relationships among these concepts (Garrison 2000). Although the context of this research is firmly grounded in second level education, the most recognised field of educational research that has continuously investigated ICT-supported learning environments is that of online learning in higher education. Therefore, the focus of this research investigation looked toward models in this field in an effort to inform the processes for supporting discourse in teaching and learning.
2.4 The Processes for Supporting Discourse

On-going research into how the features of text-based language used in technology-mediated communication (TMC) can begin to determine the correct mix of structure, dialogue and learner autonomy has led to the development of a multitude of visual frameworks attempting to model the processes and conditions under which teaching and learning is best supported in both online and blended learning environments. However, the Community of Inquiry (CoI) model developed by Garrison et al. (2000) has received the greatest deal of attention both in the areas of online and blended learning within higher educational research. Their seminal paper titled: ‘Critical inquiry in a text-based environment: Computer conferencing in higher education’ has been cited more than 3,000 times (as reported by Google Scholar April 2016) and has since provided the foundations for valuable empirical research within learning theory across multiple disciplines and in varied educational settings.

Garrison et al. (2000) first developed the CoI model to investigate how the features of text-based language used in TMC might promote critical thinking and reflection. According to Garrison and Shale (1990), TMC is the hallmark of online and blended learning because it allows both teachers and learners to structure dialogue much like how an educational transaction would occur in a traditional classroom environment. In evaluating the features of text-based language, Rourke, Anderson, Garrison and Archer (1999), Garrison et al. (2001), and Anderson et al. (2001), developed the Community of Inquiry template which has proved to be an essential tool in analysing and coding transcripts and guiding research into the use of TMC as a method for structuring dialogue within online and blended learning. The CoI template provided categories and indicators of the elements of a CoI that have been used over the years to test the structure of the model (Arbaugh & Hwang 2006; Garrison, Cleveland-Innes & Fung 2004; Shea, Li & Pickett 2006) to explore various aspects and issues associated with online learning (Garrison & Arbaugh 2007) as well as providing the inspiration for the development of the Community of Inquiry survey (Swan et al., 2008) to gather quantitative data using an online questionnaire. This survey measures perceptions based on the elements of a CoI in an attempt to provide a constructivist perspective to better understand the dynamics of online learning and support TMC.
2.4.1 The Community of Inquiry Model

The CoI model represents a process of creating a deep and meaningful (constructivist-collaborative) learning experience through the development of three interdependent elements; social presence, cognitive presence and teaching presence. Social presence is “the ability of participants to identify with the community (e.g., course of study), communicate purposefully in a trusting environment, and develop inter-personal relationships by way of projecting their individual personalities” (Garrison 2009, p. 352). Cognitive presence is “the extent to which the participants in any particular configuration of a community of inquiry are able to construct meaning through sustained communication” (Garrison et al. 2000, p. 11). Teaching presence is “the design, facilitation, and direction of cognitive and social processes for the purpose of realising personally meaningful and educationally worthwhile learning outcomes” (Anderson et al. 2001, p. 5). Finally, it is also important to note the three overlapping areas found within each pair of elements; supporting discourse, setting climate, and selecting content. These areas represent key responsibilities and features of an authentic educational experience. The CoI model shown in Figure 2.4 illustrates the relationship between the core elements and their intersecting features.

![Community of Inquiry Diagram](image-url)
Based on these constructs, Swan, Garrison and Richardson (2009) suggest that the CoI model takes into account the various stakeholder groups involved in online learning (teachers, learners) and what each can do to make their learning a successful experience. Key indicators for each of the elements were further generated and tested to explicate the elements and provide a means to investigate the nature of online learning experiences. Subsequently, as was presented in Garrison et al. (2004), these indices can then be used to “operationalise the community of inquiry model in terms of assessing online transcripts and development more objective instruments” (p. 63), and to diagnose educational transactions in order to enhance teaching interventions. It should also be noted that significant correlations have been found between learner satisfaction, perceived learning, a sense of community, and social, cognitive and teaching presence (Akyol & Garrison 2008; Arbaugh 2001, 2008; Fredericksen, Pickett, Shea, Pelz & Swan 2000; Gunawardena & Zittle 1997; Hackman & Walker 1990; Richardson & Swan 2003; Rovai 2002; Shea et al. 2006; Shea, Li, Swan & Pickett 2005; Sherry, Fulford & Zhang 1998; Stein et al. 2007; Swan 2001).

Arbaugh Bangert and Cleveland-Innes (2010) note that the application of the CoI model is suited to ‘soft’ disciplines where teaching and learning is constructivist-oriented and iterative, with emphasis placed on reflective practice and the development of transferrable skills and high-level cognitive presences are achieved. However, cognitive presence by itself will not be sufficient enough to sustain a CoI. Garrison et al. (2000) suggest that any one of the three core elements; social, cognitive or teaching presence, by itself is insufficient for the development of high levels of critical thinking and reflection, but rather these three elements have to interact with one another to best create the conditions for the construction and co-construction of knowledge, e.g. as important as cognitive presence is within an educational transaction, individuals must feel comfortable in relating to each other. A successful community of learning is nurtured within the broader social-emotional context of the educational transaction. Garrison et al. (2000) suggested that high levels of social presence with accompanying degrees of both participation and contribution are necessary for the development of higher-order thinking skills and collaborative interaction. Garrison and Anderson (2003) stressed the role of social presence in forming a community of learners, saying that “it is inconceivable to think that one could create a community without some degree of social presence”, (p. 49).
2.4.2 Social Presence: Purposeful Communication

Of the three elements of the CoI, social presence has received the most attention (Bartruff & Headley 2009; Garrison & Arbaugh 2007) largely because of educators’ scepticism of the effectiveness of TMC to support both the social and interpersonal communication required for connecting teachers and learners (Lowenthal 2009). The construct of social presence can be traced back to Mehrabian’s (1968) concept of immediacy, which he defined as the “communication behaviours that enhance closeness to and nonverbal interaction with another” (p. 203). His research suggested that nonverbal cues such as facial expressions, body movements, and eye contact increase the sensory stimulation of people which leads to more affective interactions. Early researchers, referencing Short et al.’s (1976) original theory of social presence, focused on why TMC, although perceived to be inherently antisocial and impersonal, really is not (Walther 1996; Walther, Anderson & Park 1994). Short et al. (1976) contended that different communication media convey varying degrees of social presence based on their ability to transmit nonverbal and vocal information. This notion however was challenged by Baym (1995), Gunawardena and Zittle (1997) and Walther (1994) who showed that perceived social presence in online interactions varies among participants in the same mediated conversations and indeed, that many participants perceived online discourse as more personal than traditional classroom discussion. Later, researchers of online learning (Danchak, Walther & Swan 2001; Gunawardena 1995; Gunawardena & Zittle 1997; Richardson & Swan 2003; Tu 2000) also turned to the theory of social presence but reconceptualised it, focusing on how people use communication media rather than any supposed inherent qualities of them (Lowenthal 2009). Users seem to compensate for the communicative lack of written discourse with linguistic inventions and adaptations in order to express the meta-communicational features of non-verbal communication with appropriate orthographical strategies (e.g., emoticons, typographical marks and other textual features, including the use of capital and lowercase letters, ellipsis, exclamation marks, as well as typing errors) (Murphy & Collins 1997). In this way, a higher degree of familiarity and intimacy in content, style, structures, and timing of the exchanged postings would not only be a linguistic adaptation to incorporate colloquial and informal registers, but could also strike the balance between the features of the medium and an acceptable level of immediacy (Danchak et al. 2001).
Social presence is now a central concept in online learning and is now commonly understood as the ability of people “… to project their personal characteristics into the community, thereby presenting themselves to other participants as ‘real people’” (Garrison et al. 2000, p. 89). Researchers have shown, to varying degrees, a relationship between social presence and learner satisfaction (Gunawardena 1995; Gunawardena & Zittle 1997; Richardson & Swan 2003), social presence and the development of a community of learners (Rourke et al. 1999; Rovai 2002), and social presence and perceived learning (Richardson & Swan 2003). Because of results like these, researchers continue to explore different ways to establish and maintain social presence. However, in comparison to the overall research on the CoI, there is surprisingly little guidance on specific ways of establishing social presence.

Rourke et al. (1999) identified a list of indicators of social presence that can be seen as guidance. According to this framework, social presence can be classified through a series of indicators that fit into the following categories: affective responses, interactive responses and cohesive responses. Rourke et al. (1999) found that participants engaged in certain behaviours during discussions to establish and further the degree of social presence: expression of emotions, use of humour and self-disclosure [affective]; continuing a thread, quoting from others’ messages, referring explicitly to others’ messages, asking questions, complimenting and expressing appreciation or agreement [interactive]; vocatives, addresses, making reference to the group by using inclusive pronouns; and using phatics and salutations [cohesive]. The definitions for the indicators and examples of each are summarised in Table 2.1.

The first category of affective responses or affective interaction includes elements such as emotion, feelings, mood, closeness, warmth, affiliation, attraction and openness. Rourke et al. (1999) refer to this as ‘socio-emotional communication’. Rourke et al. (1999) note that, in a context of text-based computer conferencing, affective responses may be reflected in the use of emoticons, humour and self-disclosure. Their second category is defined as interactive responses. Rourke et al. (1999) note that using the ‘reply’ feature to post messages, quoting directly from the conference transcript and referring explicitly to the content of others’ messages are all types of interactive response within TMC. Other examples which they cite include complimenting, expressing appreciation or agreement and asking questions.
Table 2.1 Categories & Indicators of Social Presence (Rourke et al. 1999)

<table>
<thead>
<tr>
<th>Categories</th>
<th>Indicators</th>
<th>Definitions</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affective</td>
<td>Expression of emotions</td>
<td>Conventional or unconventional expressions of emotion, repetitious punctuation, conspicuous capitalisation, emoticons.</td>
<td>“I just can’t stand it when ...!!!” “ANYBODY OUT THERE!”</td>
</tr>
<tr>
<td></td>
<td>Use of humour</td>
<td>Teasing, cajoling, irony, understatements, sarcasm.</td>
<td>The banana crop in Edmonton is looking good this year.</td>
</tr>
<tr>
<td></td>
<td>Self-disclosure</td>
<td>Presents details of life outside of class, or expresses vulnerability.</td>
<td>“Where I work, this is what we do ...” “I just don’t understand this question”</td>
</tr>
<tr>
<td>Interactive</td>
<td>Continuing a thread</td>
<td>Using reply feature of software, rather than starting a new thread.</td>
<td>Software dependent, e.g., “Subject: Re” or “Branch from”</td>
</tr>
<tr>
<td></td>
<td>Quoting from others’ message</td>
<td>Using software features to quote others entire message or cutting and pasting selections of others’ messages.</td>
<td>Software dependent, e.g., “Martha writes:” or text prefaced by less-than symbol &lt;</td>
</tr>
<tr>
<td></td>
<td>Referring explicitly to others’ messages</td>
<td>Direct references to contents of others’ posts.</td>
<td>“In your message, you talked about Moore’s distinction between ...”</td>
</tr>
<tr>
<td></td>
<td>Asking questions</td>
<td>Students ask questions of other students or the moderator.</td>
<td>“Anyone else had experience with WEBCT?”</td>
</tr>
<tr>
<td></td>
<td>Complimenting, expressing appreciation</td>
<td>Complimenting others or contents of others’ messages.</td>
<td>“I really like your interpretation of the reading”</td>
</tr>
<tr>
<td></td>
<td>Expressing agreement</td>
<td>Expressing agreement with others of content of others’ messages.</td>
<td>“I was thinking the same thing. You really hit the nail on the head.”</td>
</tr>
<tr>
<td>Cohesive</td>
<td>Vocatives</td>
<td>Addressing or referring to participants by name.</td>
<td>“I think john made a good point.” “John, what do you think?”</td>
</tr>
<tr>
<td></td>
<td>Addresses or refers to the group using inclusive pronouns</td>
<td>Addresses the group as we, us, our, group.</td>
<td>“Our textbook refers to ...” “I think we veered off track ...”</td>
</tr>
<tr>
<td></td>
<td>Phatics, salutations</td>
<td>Communication that serves a purely social function; greetings, closures.</td>
<td>“Hi all!” “That’s it for now” “Were having the most beautiful weather”</td>
</tr>
</tbody>
</table>

The final category in the instrument is cohesive responses, which involves building and sustaining a sense of group commitment. This category includes the indicators of phatics and salutations that serve a purely social function, vocatives or addressing participants by name, and use of inclusive personal pronouns to address the group.
Rourke et al. (1999) used the instrument as a coding scheme to generate an aggregate social presence density rating of instances of social presence in online transcripts by quantifying the occurrences of each of the categorical indicators of social presence. The authors concluded that the instrument “is able to expose and quantify important differences in social presence” in text-based, asynchronous communications. They also concluded that “further study is needed, especially using instruments that triangulate participant perception of social presence and its value, and the relationship between social presence and objective measures of learning outcomes”. Furthermore, although the literature dealing with social presence is rather extensive, the majority of research appears to focus on online learning within higher education.

However, Nippard and Murphy (2007) noted that expressions of social presence in second level education occurred most often in the context of digressions that drew attention away from the delivery of subject content. In addition, pupils demonstrated social presence using discourse conventions transferred from informal social contexts of instant messaging. Digressions from the curriculum, i.e., informal and non-curricular related attempts at social interaction, allow learners, and to a lesser degree teachers, to diverge from the structure of the content. Romiszowski (1995) recognised that asynchronous text-based interaction is particularly susceptible to digression and teachers should control the direction that interactions take. Nippard and Murphy (2007) suggest that this off-content interaction plays a role in fostering social presence because pupils exhibit much of their affective, cohesive and interactive responses in this context. However, teachers may find that using this approach requires the establishment of procedures and policies or rules in order to promote best practices by the pupils. These procedures might be communicated through teacher modelling the types of affective, interactive and cohesive responses that could be communicated. In other cases, explicit procedures may need to be put in place to more clearly define the behaviours that should be engaged in. This may be particularly necessary in relation to discourse conventions. If instant messaging is encouraged and if pupils’ preference is to use a more relaxed form of the language, the activities designed to promote use of interaction may well need to be tolerant of a more diverse mode of communication than is typically common in educational settings. Likewise, teachers interested in promoting social presence will need to be tolerant of digressions and willing to accept its role in facilitating cognitive presence.
2.4.3 Cognitive Presence: Meaningful Construction

Although socio-emotional communication may well be important, by itself, it is not sufficient for the development of traditional classroom learning. Ultimately, effective learning must take into consideration both the internal cognitive processes as well as the external contextual elements that precipitate and shape discourse. The purpose of a CoI therefore is the initiation of meaningful learning and achievement of cognitive processes (i.e., cognitive presence). Cognitive presence represents the analysis, construction, and confirmation of meaning and understanding within a community of learners through supported discourse and reflection (Garrison & Anderson 2003).

Based on the Dewian view of practical inquiry (Dewey 1933) cognitive presence is operationalised through four phases of the Practical Inquiry model shown in Figure 2.5 (Garrison et al. 2001). The first phase is a triggering event, where an issue or problem is identified for further inquiry. Next is exploration, where learners explore the issue both individually as well as a community, through discourse and reflection. The third stage is integration, where learners construct meaning from their ideas developed during exploration. Finally, the process culminates in resolution, where learners apply their new knowledge. Hence, the educational goal is to move learning through all of the four phases of the inquiry process to ensure a successful outcome.

![Figure 2.5 Practical Inquiry Model (Garrison et al., 2001)](image)
The two axes that structure the model are action-deliberation and perception-conception. The first axis is discourse and reflection, which together constitute the shared and private worlds. The second axis is the assimilation (analysis) of information and the construction (synthesis) of meaning (Akyol & Garrison 2011). The quadrants reflect the logical (idealised) sequence of practical inquiry (i.e. critical thinking) and correspond to the phases of cognitive presence (Garrison et al. 2000).

The phases of the Practical Inquiry model are the idealised logical sequence of the process of critical inquiry and therefore must not be seen as immutable. The first phase (lower quadrant) of the model reflects the initiation phase of critical inquiry and is considered the triggering event. Here an issue, dilemma or problem that emerges from experience is identified or recognised. In an educational context, the teacher often explicitly communicates the learning challenges or tasks that become triggering events. However, in a more democratic and non-hierarchical application of TMC, any group member may purposively or indirectly add a triggering event to the discourse. A critical role of the teacher (actualising teacher presence) is to initiate, shape, and in some cases, discard potentially distracting triggering events so that the focus stays on the attainment of intended learning outcomes (Garrison et al. 2000).

The second phase of the process is exploration. In this phase, participants shift between the private, reflective world of the individual and the social exploration of ideas. Early in this phase learners are required to perceive or grasp the nature of the problem and then move towards a fuller exploration of more relevant information. This exploration takes place within a community of learning by iteratively moving between the private and shared worlds, that is, between supported discourse and reflection (Garrison et al. 2000). At the end of this phase learners begin to be more selective with regard to what is relevant to the issue or problem. This is a divergent phase characterised by brainstorming, questioning, and the exchange of information.

The third phase, integration, is characterised by constructing meaning from the ideas generated in the exploratory phase. During the transition from the exploratory phase, learners begin to assess the applicability of ideas in terms of how well they connect and describe the issue or event under consideration. Again, learners move repeatedly...
between supported discourse and reflection. This phase is the most difficult to detect from a teaching or research perspective. Evidence of the integration of ideas and the construction of meaning must be inferred from communication within the learning community (Garrison et al. 2000). This phase requires active teaching presence to diagnose misconceptions, to provide probing questions, comments, and additional information in an effort to ensure progressive cognitive development, and to model the critical thinking process. Most often learners will be more comfortable remaining in a continuous exploration mode, therefore teaching presence is essential in moving the process to more-advanced stages of critical thinking and cognitive development.

The fourth phase is a resolution of the issue or problem by means of direct or vicarious action. According to Garrison et al. (2001), in non-educational settings, this means implementing the proposed solution or testing the hypothesis by means of practical application. However, in an educational context, the concept is somewhat more difficult. It usually entails a vicarious test using thought experiments and consensus building within the learning community. Progression to the fourth phase requires clear expectations and opportunities to apply newly constructed knowledge.

Educationally, the end of this phase may require moving on to a new problem with the assumption that learners have acquired useful knowledge. In a less-contrived situation, the results of the application phase lead to further problems and new triggering events, thus causing the process to start over. At this point there may be an intuitive leap apparently shortcutting the logical cycle of inquiry. This process of apparent skipping of phases or making conceptual leaps introduces the concepts of intuition and insight (Garrison & Anderson 2003). Research on cognitive presence has been mixed. It has been reported in previous research (Fahy 2005; Garrison et al. 2000, 2001; Garrison & Cleveland-Innes 2005; Kanuka & Anderson 2007; Kanuka, Rourke & Laflamme 2007; McKlin, Harmon, Evans & Jones 2001; Meyer 2003; Rourke & Kanuka 2009; Stein et al. 2007; Vaughan & Garrison 2005) that learners within online courses tend not to reach the higher stages of cognitive presence, i.e., integration, application and resolution, but instead appear to stall at the lower levels reflecting introduction to, and surface exploration of, course topics and other issues. Hence, progression to higher stages of cognitive presence requires teaching presence.
2.4.4 Teaching Presence: Educational Organisation

Teaching presence begins before the learning commences as the teacher, acting as an instructional designer, plans and prepares the course of study and it continues during the course as the teacher facilitates discourse and provides direct instruction when required (Anderson et al. 2001). Through teaching presence, formal learning that facilitates personally relevant and educationally defined outcomes is achieved. However, this does not deject individual learning that occurs through independent or self-directed study, but it is only through the active intervention of a teacher that a powerful communications tool such as TMC becomes a useful instructional and learning resource (Anderson et al. 2001). Identifying the types of teaching presence interventions gives some clues to developing better support tools for online learning.

Shea et al. (2006) argued that teaching presence supports the development of higher levels of community among online learners, and that goal-directed collaborative interaction known to support a sense of connectedness and active learning can be effectively orchestrated by the three elements of teaching presence: effective design, facilitation and direction of social and cognitive processes. Under the category of instructional design and organisation within the CoI model, Anderson et al. (2001) include setting curriculum, designing methods, establishing time parameters, utilising the medium effectively, and establishing group norms via conventions of ‘netiquette’. The second component of teaching presence within the CoI model is facilitating discourse. The task of facilitating discourse is necessary to maintain learner engagement and refers to “focused and sustained deliberation that marks learning in a community of inquiry” (Anderson et al. 2001, p. 7). The indicators that reflect discourse facilitation include the identification of areas of agreement and disagreement, seeking to reach a consensus and understanding, encouraging, acknowledging and reinforcing learner contributions, setting the climate for learning, drawing in participants, prompting discussion, and assessing the effectiveness of the process. Finally, Anderson et al. (2001) include indicators of direct instruction in their framework for the analysis of teaching presence. These indicators include presenting content and questions, focusing the discussion on specific issues, summarising discussion, confirming understanding, diagnosing misperceptions, injecting knowledge from diverse sources and also responding to technical concerns.
Anderson et al. (2001) describe the design and organisation aspect of teaching presence as the planning and design of the structure, process, interaction, and evaluation aspects of online learning. Teachers must be more explicit and transparent regarding these aspects of online learning because the social cues and norms of the traditional classroom are absent (Anderson 2001; Coppola, Hiltz & Rotter 2002; Palloff & Pratt 1999). Some of the activities comprising this category of teaching presence include re-creating teaching aids, learning resources and class notes in the learning environment, providing personal insights into the subject content, creating a desirable mix of, and a schedule for, individual and group activities, and providing guidelines on how to use the medium effectively. These are particularly important activities because clear and consistent task structure along with engaged teachers and supported discussions have been found to be the most consistent predictors of successful online learning (Swan 2002, 2003). Of the three components of teaching presence this is the one most likely to be performed exclusively by the teacher. These activities are for the most part completed prior to beginning the learning, but adjustments can be made as the learning progresses (Anderson et al. 2001). The structural orientation of this component is what makes it a distinctive aspect of teaching presence (Arbaugh & Hwang 2006). If there is no set of activities, no timeline, no protocol, no format for materials and no evaluation criteria, disorder will ensue in the online environment (Berger, 1999; Hiltz & Wellman, 1997). Design and organisation provide the context for which discourse and instruction have meaning.

Related to Chickering and Gamson’s (1987) idea of contact between teachers and learners and the reciprocity and cooperation between learners, Anderson et al. (2001) conceptualise facilitating discourse as the means by which learners are engaged in, interacting about, and building upon, the information provided in the learning materials. This component of teaching presence is quite consistent with findings supporting the importance of participant interaction in online learning effectiveness (Arbaugh 2000, 2005; Hiltz & Turoff 2002; Sherry et al. 1998; Yoo, Kanawattanachai & Citurs 2002). This role requires more than merely facilitating discussions because it is required to attain the learning objectives in the course. This characteristic is associated with sharing meaning, identifying areas of agreement and disagreement, and seeking to reach a consensus and understanding. Therefore, facilitating discourse requires the teacher to review and comment upon the learners
comments, raise questions and make observations to move discussions in a desired direction, keep the discussions moving efficiently, draw out the inactive learners, and limit the activity of dominating posters when they become detrimental to the learning of the group (Anderson et al. 2001; Brower 2003; Coppola et al. 2002; Shea, Fredericksen, Pickett & Pelz 2003). The fact that this engagement must be a shared activity makes facilitating discourse a distinct component of teaching presence (Arbaugh & Hwang 2006). Unlike design and organisation, which for the most part must be completed by the teacher alone before the learning begins, facilitating discourse must be accomplished by the teacher in concert with a community of learners (Rovai 2001, 2002). While an effectively designed task creates opportunity for an online community, the community will not be created unless participants actually engage each other. The fact that this activity is done within the context of a community also distinguishes it from direct instruction, which can be focused more on individualised feedback between the teachers and learners (Anderson et al. 2001).

Anderson et al. (2001) contextualised direct instruction as the component of teaching presence where the teacher provided intellectual and scholarly leadership in part through the sharing of their subject matter knowledge with the learners. They also contend that a subject matter expert and not merely a facilitator must play this role because of the need to diagnose comments for accurate understanding, injecting sources of information, and guiding discussions in useful directions, scaffolding learner knowledge to raise it to a new level. In addition to the sharing of knowledge by a content expert, direct instruction is concerned with the indicators that assess the discourse and the efficacy of the educational process. Responsibilities of the teacher here are to facilitate discourse and reflection by presenting content, using various methods of assessment and feedback. Hence, explanatory feedback is crucial as this type of communication must be perceived in the context of a high level of social presence (Arbaugh 2001; Baker 2004; Gorham 1988; Richardson & Swan 2003) to be effective. Teachers must have both content and pedagogical expertise to make links between contributed ideas, diagnose misconceptions and inject knowledge from textbooks, articles, as well as internet-based materials. The fact that direct instruction requires a content expert makes it a distinctive component of teaching presence, as only content experts can recognise subject-related misconceptions or refer learners to additional learning materials relevant to the task at hand (Arbaugh & Hwang 2006).
As reported by Arbaugh and Hwang (2006), the design, facilitation and direction of social and cognitive processes (i.e. teaching presence) is a mechanism for bridging the transactional distance between teachers and learners within online education and clarifying the relationships among structure, dialogue and autonomy (Moore 1990). Therefore, it is becoming increasingly apparent that if the CoI model is to be used within second level education, teaching presence will also have a significant impact on the organisation, communication and interaction (i.e. the convergent principles of design and implementation) required for developing an integrated pedagogical and technological approach in ICT-supported learning environments (Richards 2006).

However, if the design, facilitation and direction of social and cognitive processes are to inform the quality of learning and efficacy of teaching, then we must now look at the intersection between social and cognitive presence (i.e. supporting discourse).

### 2.4.5 Supporting Discourse: A Critical Intersection

Redmond and Lock (2006) argue that the intersection between social and cognitive presence is where learners move beyond the exchange of information to a more reflective and in-depth investigation or analysis. Here they compare, contrast and connect ideas from their peers and the content. Using informed voices, the learners' discourse should demonstrate an increasing breadth as well as depth of knowledge. Learners continue to share and question for understanding in addition to justifying their thoughts, acknowledging and building on the ideas of others and linking or connecting to other sources while creating solutions or recommendations (Garrison et al. 2001). Working with a group of equal-status peers to solve a problem is particularly conducive to the development of critical thinking and reflection as it exposes individuals to different perspectives and interpretations of a problem or idea (Abrams 2005). Supporting discourse in group work is where learners integrate their prior knowledge with multiple perspectives and engage in higher order thinking. However, the most common pitfall for supporting discourse within online learning is taking for granted that social interaction will automatically take place just because an environment makes it technologically possible (Kreijns, Kirschner & Jochems 2003). Moreover, Woo and Reeves (2007) suggest that not all discourse is meaningful. Only when the interaction has a direct influence on the learners' intellectual growth can we say the interaction is meaningful (Hirumi 2002; Vrasidas & McIsaac 1999).
According to Kearsley (1995), social interaction in ICT-supported learning environments must be organised or it is unlikely to occur or be meaningful. Liaw and Huang (2000) and Northrup (2001) determined that within a learning environment interaction does not just happen, but must be intentionally designed into the learning. If we discount the problem that most teachers do not know what they have to do in order to encourage social interaction (Kearsley 1995; Rourke 2000), what remains is the observation that a majority of teachers, either consciously or unconsciously, take social interaction for granted (Kreijns et al. 2003). They think that because in face-to-face learning groups social interaction is ‘easy’ to achieve if not already there, the same patterns will be encountered within online learning. However, Rourke (2000) concluded that social interaction can no more be taken for granted in online learning than it can be in face-to-face settings such as traditional classroom-based settings.

Organisational researchers such as Olson and Olson (2000) note that “with the invention of groupware, people expect to communicate easily with each other and accomplish difficult work even though they are remotely located or rarely overlap in time” (p. 139). Wagner (1994) concludes that the “growing ‘folk’ acceptance of a causal relationship between system interactivity [the degree a system allows for interaction] and instructional interaction has placed an unrealistic expectation on interactive technologies to ensure that instructional interaction [does] occur”, (p. 8).

The use of TMC itself introduces barriers not present within face-to-face settings. First, it differs from face-to-face with respect to media richness; “the medium’s capacity for immediate feedback, the number of cues and senses involved, personalisation, and language variety” (Rice 1993, pp. 453-453). Learners rate TMC as low in media richness, because it constrains both their vocabulary for expressive and the direct communication for accomplishing certain tasks such as decision making. Learners rated face-to-face communication to be the most media rich. Media-poor TMC impacts the level of communication and ultimately, social interaction (Daft & Lengel 1984; Daft, Lengel & Trevino 1987). Further, the use of TMC can cause oral and written communication apprehension, potentially retarding interaction (Berge 1997; Fishman 1997). McCroskey (1977) defined communication apprehension as “an individual’s level of fear or anxiety associated with either real or anticipated communication with another person or persons” (p. 78). Accordingly, this apprehension may influence the degree of social interaction (Muirhead 1999).
Therefore, just providing pupils in online learning with more communication media than they already have does not necessarily foster nor ensures social interaction. Although this media can contribute to a more suitable condition for the execution of communication tasks, they do not guarantee that the desired social interaction will take place nor do they do guarantee that the social interaction will be meaningful. Unfortunately, teachers and learners still lack sound theoretical foundations for determining what are good quality meaningful interactions (Woo & Reeves 2007).

The nature of interaction in various forms of learning environments has been defined in a variety of ways, based upon the participants' level of involvement in a specific learning opportunity and the objects of interaction such as other participants or subject materials. The nature of interaction is also dependent upon the contexts in which interaction occurs, in a face-to-face situation or at a distance. Moore's (1989) classic definition of interaction in online learning in higher education is based upon a communication-based framework, defining the sender and receiver of three types of interaction: learner-content, learner-teacher, and learner–learner. Also within the context of online learning, Wagner (1994) defined interaction as “the reciprocal events that require at least two objects and two actions” (p. 8). Such interactions are said to occur when these two objects and events reciprocally influence each other. Hillman, Willis and Gunawardena (1994) insisted that these and other past discussions of interaction overlooked the fact that all interaction is mediated via a medium in technology-based learning. On the basis of their research, Hillman et al. added a fourth kind of interaction, learner-interface interaction to Moore's three types of interaction. Finally, Sutton (2001) defined a fifth type of interaction, vicarious interaction, which takes place when a learner actively observes and processes both sides of a interaction between two other learners or between another learner and teacher. Taking into account the previous definitions, Muirhead and Juwah (2005) described interaction as “a dialogue or discourse or event between two or more participants and objects which occurs synchronously and/or asynchronously mediated by response or feedback and interfaced by technology” (p. 13). According to Muirhead and Juwah (2005), interaction serves a wide range of functions in the learning process: promoting active learning, enabling effective facilitation, allowing learner input within the learning process, allowing the development of higher order knowledge and abilities, and enhancing the quality of teaching-learning experiences.
Of course, every interaction in an ICT-supported learning environment does not have an influence on increased learning, idle chat, online surfing, or mindlessly clicking web pages is unlikely to lead to substantive learning even though learners are interacting with other objects (Woo & Reeves 2007). In this context, Vrasidas and McIsaac (1999) focused on not just interaction but meaningful interaction. Hirumi (2002) also mentioned meaningful interaction emphasising the quality of interaction on learning. Meaningful interaction is not just sharing personal opinions. Instead, the interaction must stimulate the learners' intellectual curiosity, engage them in productive instructional activities, and directly influence their learning (Hirumi, 2002; Vrasidas & McIsaac, 1999). Depending on how learning is defined, the image of meaningful interaction is changed (Deubel, 2003; Hannafin, 1989; Vrasidas, 2000). Therefore, meaningful interaction is strongly related to the ontological and epistemological assumptions underlying the development of ICT-supported learning.

Following a review of the CoI, Rourke and Kanuka (2009) concluded that deep and meaningful learning did not occur as described in the framework because “students are not engaged in the constituent processes” (p. 39) as proposed by the framework. However, many studies have shown learners are engaged in the constituent processes (Akyol & Garrison 2008; Meyer 2004; Pisutova-Gerber & Malovicova 2009). Not only do these studies refute the conclusions of Rourke and Kanuka’s (2009) review, they support the explanations offered in earlier studies concerning why learners were not reaching the higher phases of critical thinking and inquiry (Garrison, et al. 2000; Garrison & Arbaugh 2007; Garrison & Cleveland-Innes 2005; Garrison & Vaughan 2008). Those studies claimed the apparent inability to move to integration and resolution phases very likely had to do with the issues of teaching presence. Garrison and Arbaugh (2007) cited several references which support the contention that it was a design (i.e., the nature of the learning activities), and a facilitation issue. Further, Ice, Akyol and Garrison (2009) also indicated that this may also be a function of the epistemological orientation of the instructional design and organisation components. Hence, if we consider using the CoI for the integration of ICT in D&T education, teaching presence will have a big influence on the teaching and learning experience. However, the context of these processes is set in online learning in higher education, it is therefore necessary, for this research to investigate the interrelationship between the processes and the conditions for supporting discourse in second level education.
2.5 The Conditions for Supporting Discourse

As is evident in the course of literature review, constructivism has manifested itself as being a foundational condition for supporting discourse in second level education:

- D&T education and the process of design follow a constructivist approach
- ICT requires a transactional model in support of a constructivist approach
- CoI model and its interrelated processes follows a constructivist approach

Constructivism has provided different forms of theoretical bases for ICT-supported learning environment as well as for traditional (face-to-face) learning environments (Jonassen, Davidson, Collins, Campbell & Haag 1995; Jonassen 1999). Although there are many variants of the constructivist theory of learning (Fosnot 1996) they share the perspective that learning is the process of creating meaning. In other words, constructivists accept that learning requires the personal interpretation of phenomena and sharing the representation and manipulation of those interpretations with others.

Therefore, in an ICT-supported learning environment designed on the principles of constructivism, meaningful interaction should include responding, negotiating internally and socially, arguing against points, adding to evolving ideas, and offering alternative perspectives with one another while problem solving in real world situations (Jonassen et al. 1995; Lapadat 2002; Lave & Wenger 1991; Vrasidas 2000; Vygotsky 1978). However, Kirschner, Sweller and Clark (2006) have found that without significant organisation, learners may find working on real-world problems to be frustrating, ineffective and demoralising. The transactional distance involved can make this especially true for pupils in ICT-supported environments, leading to attrition problems (Ludwig-Hardman & Dunlap 2003). To pre-empt this challenge Dunlap, Dobrovolny and Young (2008) have used Kolb's (1984) model of experiential learning to structure and sequence the pupils' work on their real-world problems so that frustration and other effects of transactional distance are minimised. Therefore, since this research is concerned with reducing the transactional distance between teachers and pupils and supporting discourse in second level education, experiential learning is recognised as one of the conditions of teaching and learning that can evidence design-based activity using ICT-supported learning environments.
2.5.1 Guiding the Learning Experience

According to Kolb (1984), learning is “the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience” (p. 41). Kolb's experiential learning theory provides a framework for designing active, collaborative, and interactive learning experiences that supports transactional process of learning (Bolan 2003; Kolb 1984).

Kolb (1984) conceptualises learning from experience in terms of four components, each of which requires the pupil to invoke specific abilities; concrete experience draws on the pupil's willingness to experience new things; reflective observation requires an ability to consider experiences from a variety of perspectives in order to find meaning; abstract conceptualisation requires the ability to analyse and integrate new ideas and concepts, drawing logical conclusions through reflective consideration of new experiences; and active experimentation requires pupils to apply new learning to practice, problem solving, and decision making, which leads to new concrete experiences. As Figure 2.6 illustrates, these abilities are integrated into phases of a cyclical process commonly referred to as the experiential learning cycle.

![Figure 2.6 Experiential Learning Cycle (Kolb 1984)](image-url)
Describing how experiential learning and Kolb's model in particular can be used in instructional design, Svinicki and Dixon (1987) propose that certain frequently used teaching activities can support different phases of the cycle and “by constructing learning sequences that lead learners through the full cycle, an instructor should be able to foster a more complete learning than can be gained from a single perspective” (p. 142). Svinicki and Dixon (1987) provide the following examples for teachers:

- To support concrete experience, teachers can employ laboratories, fieldwork, readings, observations, simulations, games, problem sets, films, or examples
- To support reflective observation, teachers can assign discussions, journals, portfolios, brainstorming activities, thought questions, or rhetorical questions
- To support abstract conceptualisation, teachers can provide analogies, model-building activities, assign readings or projects, or deliver specialised lessons
- To support active experimentation, teachers can incorporate simulations, case study research, lab experiments, homework activities, fieldwork, or projects

Therefore, to produce a complete and full experiential learning cycle, the teacher would select an activity from each phase and guide the pupils through them in order. In this way, Kolb’s model offers a practical framework for designing and structuring learning activities that supports pupils as they learn from experience while working on a context-rich, real-world project within an ICT-supported learning environment. However, most teachers do not know what they have to do in order to guide and scaffold interactions that result in effective learning (Kearsley 1995; Rourke 2000). Kirschner et al. (2006) highlighted the problems sometimes associated with the minimal-guidance approach towards teaching that experiential learning advocates. On one side of this argument are those who believe people learn best in an unguided or minimally guided environment, generally defined as one in which the learners, rather than being presented with the essential information, must discover or actually construct information for themselves (Bruner 1961; Papert 1980; Steffe & Gale 1995). On the other side are those who suggest that novice learners should be provided with direct guidance on concepts and procedures required by a discipline and should not be challenged to discover those procedures by themselves (Cronbach & Snow 1977; Klahr & Nigam 2004; Mayer 2004; Shulman & Keislar 1968).
However, similar to the transmission model of learning, the praxis of this model also involves determining the appropriate mix of guidance. Although the exact nature of the relationship between direct guidance and minimal guidance is not always clear, both must be reflected in the design of a pedagogical model for supporting discourse.

Direct instructional guidance is defined as providing information that fully explains the concepts and procedures that pupils are required to learn (Kirschner et al. 2006). The minimally guided approach has been called by various names including: discovery learning (Anthony 1973; Bruner 1961); problem-based learning (Barrows & Tamblyn 1980; Schmidt 1983); inquiry learning (Papert 1980; Rutherford 1964). These approaches challenge pupils to solve ‘authentic’ problems or acquire complex knowledge in information-rich settings based on the assumption that having pupils construct their own solutions leads to the most effective learning experience. Furthermore, they appear to assume that knowledge can best be acquired through experience based on the procedures of the discipline, i.e., seeing the pedagogic content of the learning experience as identical to the methods and processes or epistemology of the discipline being studied (Kirschner 1992). Minimal guidance is offered in the form of process- or task-relevant information that is available to pupils only if they choose to use it. Advocates of this approach imply that the instructional guidance that provides or embeds learning strategies within the instruction interferes with the natural processes by which the pupils draw on their unique prior experience and learning styles to construct new situated knowledge that will achieve their goals.

However, the goal of teaching is rarely simply to search for or discover information, but to give pupils specific guidance about how to cognitively manipulate information in ways that are consistent with a learning goal (Kirschner et al. 2006). Therefore, supporting discourse in ICT-supported learning environments will require teachers to simultaneously teach specific content while scaffolding certain goals by modelling relevant learning procedures for identifying and self-checking pertinent information. A learning procedure is the series of actions carried out to accomplish a goal (Rittle-Johnson & Schneider 2014), and knowledge of learning procedures is often termed procedural knowledge (Canobi 2009; Rittle-Johnson, Siegler & Alibali 2001). Thus, procedural knowledge is recognised as one of the conditions of teaching and learning that can evidence design-based activity using ICT-supported learning environments.
2.5.2 Structuring the Learning Process

In contrast to declarative knowledge, procedural knowledge is goal oriented and mediates problem solving behaviour. Hence, the general consensus is that procedural knowledge is the ability to execute action sequences (procedures) to solve problems. As reported by Byrnes and Wasik (1991), “procedural knowledge […] is ‘knowing how’, or the knowledge of the steps required to attain various goals” (p. 777). This knowledge develops through problem-solving activities and is tied to specific problem types (Rittle-Johnson & Schneider 2014). Procedural knowledge can be represented as a set of independent rules that associate problem states and problem solving goals with actions and consequent state changes (Corbett & Anderson 1995). Hence, procedural knowledge is the knowledge exercised in the performance of a goal and thus, includes knowledge which unlike declarative knowledge, cannot be easily articulated by the individual learner since it is typically non-conscious or tacit. Therefore, in an effort to help learners to begin to articulate this form of knowledge, which is necessary for teachers and learners to be able to discuss their performance, learning procedures or ‘learning protocols’ have been used for supporting discourse.

Beyond the field of ICT-supported learning, teachers have been using the concept of learning protocols for supporting discourse in face-to-face environments (McDonald, Mohr, Dichter & McDonald 2013). These protocols give directions for who should speak at a particular time and for how long, and who should listen at a given time. “They make clear the crucial difference between talking and listening, between describing and judging, or between proposing and giving feedback. In the process, they call attention to the role and value of each of these in learning” (McDonald et al. 2013, p. 5). Furthermore, they help to create an environment where people learn to value diverse ideas and learn from one another. Given the success that protocols have played in face-to-face interaction, Zydney, deNoyelles and Seo (2012) explored the potential of these protocols in online interactions to overcome some of the typical issues faced while teaching online. These issues include limited levels of cognitive processing under some circumstances (Maurino, Federman & Greenwald 2007), limited social interaction resulting in pupils feeling disconnected (van Tryon & Bishop 2009), and limited time and other constraints on teachers’ ability to fully guide online discussions (Maurino et al. 2007; Rourke & Anderson 2002; Seo 2007).
According to Zydney et al. (2012) learning protocols can provide a means for teachers to support the elements of a CoI - social, cognitive and teaching presence. For example, cognitive presence refers to the extent that participants are able to co-construct knowledge through sustained discourse and inquiry. Protocols may provide a structure to enable participants to build upon and integrate what one another is saying and provide a forum for divergent perspectives on a topic. To support cognitive presence, social presence is critical in providing the needed group cohesiveness and purposeful communication needed for knowledge construction. Thus, learning protocols may help to create an atmosphere where participants can learn from one another by establishing specific procedures for everyone. Finally, teaching presence is necessary to provide the design, facilitation and direction to create the social interaction required to promote meaningful learning. To establish teaching presence, protocols may provide participants with the directions to facilitate themselves, and as a result, distribute the facilitation more evenly between the teacher and the pupils, reducing the strain on the teacher of doing all the facilitation.

The concept of learning protocols is well established (Pfister, Wessner, Beck-Wilson, Miao & Steinmetz 1998; Wessner, Pfister & Miao 1999). Wessner et al. (1999) think of learning protocols as a set of potential support tools from which teachers and pupils may select from to indicate what they consider to be useful. At any time, participants may choose from a menu of specific protocols, which are then activated. However, these protocols are not forced onto the participants, but are an optional tool to use if needed in the course of an otherwise self-organised learning process (Pfister et al. 1998). When finished, participants are free to select any other protocol, or to proceed without support. Hence, the learning process is not controlled by the protocols, but can be augmented at any time when support seems appropriate.

Therefore, in light of the concerns regarding direct and minimal guidance, the use of protocols can be used to support the articulation of procedural knowledge, as they provide built-in prompts, leading to a progression in thought (Zydney et al. 2012). Since protocols are open-ended pupils can select their own topics, experience more ownership of the discussion and given the structure of protocols can be broken down into small steps there is no need for excessive training. This structure may provide easier management and facilitation of the discussion, with clearer discussion threads.
However, a unique difficulty in online learning is to gain a common understanding of the shared knowledge of the group as “efficient communication requires that each participant knows, at least approximately, what the other participants know” (Wessner et al. 1999, p. 510). Without this common background, it would require a lot of time and effort to achieve effective interaction. In online learning, due to the continuous acquisition of new knowledge of each participant, the shared knowledge is ever changing. This makes it even more important to provide systematic support to construct and represent the common knowledge of the learning group in some way. Wessner et al. (1999) propose that pupils should be able to express their knowledge in the form of a diagram with nodes and links; nodes denote specific processes (from the domain to be learned), and links denote specific relations among the processes. This led the research to consider: What kind of protocols support the development of learning processes? and thus, How can we devise a framework to help both teachers and pupils articulate a common language of understanding about learning processes?

At this stage it is important to note that procedural knowledge focuses more on the process of teaching and learning as opposed to specific individual learning outcomes. However, to develop successful learning is to begin by articulating “specific goals, specific tasks, and specific outcomes” (Rogers, Andres, Jacks & Clausen 1990). With specific learning outcomes, teachers can then determine the type of learning processes they need to support and then select the appropriate pedagogical strategy. Although the proponents of an outcomes-based education claim it’s pupil-centred, for education to be pupil-centred the pupils’ voice should be at the heart of both what is learnt and how it’s learnt (Scott 2011). The point is that we need to focus on supporting the actual learning process in order to associate the depth of learning with actual pupil-centred approaches provided by ICT-supported learning environments.

However, if we are to understand how to foster social and cognitive presence, then a greater focus needs to be placed on linking both learning processes and outcomes. Furthermore, given that teaching presence is “the design, facilitation and direction of social and cognitive processes for the purpose of realising personally meaningful and educationally worthwhile learning outcomes” (Anderson et al. 2001 p.5), this study argues that meaningful interactions should then ensue around the nature of learning outcomes as this will inform the process and the evidence of teaching and learning.
Biggs and Collis’ (1982) SOLO taxonomy provides a framework for understanding the complex web of relations between the learning process and learning outcomes. SOLO, which stands for the Structure of the Observed Learning Outcome, is a model that describes levels of increasing complexity in pupils’ understanding of subjects. As a result SOLO can be used not only in the assessment of learning in terms of its quality but in designing the curriculum in terms of the learning outcomes intended, which is helpful in implementing constructive alignment (Biggs & Collis 1982). Constructive alignment is a theory of learning that begins with the premise that pupils construct knowledge through relevant activity-based transactions, much like experiential learning, and is defined as the coherence between assessment, teaching strategies and intended learning outcomes in an educational programme. Hence, the SOLO taxonomy can be used as an instructional as well as an evaluative tool and is the only instrument available (Biggs & Collis 1982) for assessing the quality of learning in an objective and systematic way that is easily understood by teachers and learners. The SOLO taxonomy was first established by analysing pupils responses to assessment tasks (Biggs & Collis 1982; Collis & Biggs 1986) and has been validated for use in a wide range of disciplines (Hattie & Brown 2004). In developing SOLO, Biggs and Collis took into account many factors that affect pupil learning, such as prior knowledge and misconceptions, motives and intentions, and learning strategies.

The outcome of learning is revealed from the structured complexity of performance (Leung 2000). According to constructivism, learning grows cumulatively in stages in which the learned content is increasingly complex. In order to assess learning, to find out at what level a pupil is currently thinking with respect to a particular topic, it is necessary to be able to describe what the learning will be like at any particular stage. Basically, there are two aspects to structural complexity: the amount of detail in the learners response (quantitative), and how well put together that detail is (qualitative). Both are important, and can be classified within the SOLO taxonomy (Biggs 1982). The SOLO taxonomy describes levels of progressively complex understanding, through five general stages that are relevant to all subjects within all disciplines: prestructural, unistructural, multistructural, relational, and extended abstract. SOLO is a hierarchical model of structural complexity, increasing consistency, increasing number of organising dimensions and increasing use of relating principles (Hattie & Purdie 1998). Each level is intended to encompass and transcend the previous level.
As shown in Figure 2.7, in the prestructural stage of SOLO the task is not undertaken appropriately and the performance is incompetent. In the unistructural stage one or more aspects of the task are picked up and used. In the multistructural stage several aspects of the task are treated as if they were separate. In the relational stage the quantitative aspects become integrated into a coherent whole. Finally, in the extended abstract stage of the SOLO taxonomy the previous integrated whole is conceptualised at a higher level of abstraction and generalised to a new topic or area.

While many educators have used SOLO as an alternative to Bloom’s Taxonomy, which itself has some well-known problems (see Hattie & Brown 2004, pp. 35-38). Potter and Kustra (2012) believe the two are best used to complement each other, to help us think about the design of our teaching and learning in slightly different ways. As Biggs and Tang (2007, p. 80) note, “the Bloom taxonomy is a useful adjunct” for the creation of learning outcomes and appropriate teaching and learning activities. Therefore, in conjunction with Blooms taxonomy, the SOLO taxonomy can be used to design learning protocols that help learners articulate their procedural knowledge. Hence, these learning protocols can provide evidence to link the process of learning with the learning outcomes and demonstrate the individual development of the pupil.
2.5.3 Individualised Learning and Pace

If we are to support the development of the learning process and learning outcomes, then it’s more useful to look at what pupils are beginning to know and understand and work to nurture those emerging skills and abilities, rather than concentrating our attention retrospectively on those skills and abilities that have already been achieved. However, this has real implications for teaching and the development of these skills.

If we direct our teaching only to pupils in the higher stages of learning, pupils in lower stages may become frustrated, restless or discouraged, as they are not able to understand the material presented. Likewise, if we direct our teaching only to pupils in the lower stages of learning, pupils who are capable of working at higher stages may become bored, which also leads to restlessness and a loss of motivation. Similarly, targeting our teaching only to pupils in the middle stages can mean that pupils in both the higher and lower stages become frustrated, restless or discouraged.

Accordingly, there is a need to break the traditional link between whole-class teaching and instructional strategies. Teachers will increasingly have to focus on individual developmental and personalised learning for each pupil. They will have to work collaboratively rather than in isolation, and base their intervention strategies and resource use decisions on evidence of learning (what pupils do, say, make or write), rather than inference (what pupils know, understand, think or feel). Therefore, in the context of supporting discourse within second level education, individual development is recognised as being one of the conditions of teaching and learning that can evidence design-based activity using ICT-supported learning environments, and informs a pedagogical model for enhancing practice in second level education.

When we take an individual developmental approach to the process of learning the aim is to move a pupils’ understanding forward along a path of increasingly complex knowledge, skills, and abilities. A developmental approach is evidence based and focuses on the pupils’ readiness to learn, scaffolding and building on their current stage of learning and helping each pupil to progress to higher order and deeper levels of learning (Griffin, McGaw & Care 2012). A developmental approach can be viewed in opposition to a deficit approach to both teaching and intervention, which focuses on describing, then attempting to remediate the things that a pupil cannot do.
Developmental learning is conceptualised as a matter of acquiring qualitatively and quantitatively more knowledge and skills. Progress towards higher stages of skill reflects new knowledge which is then linked to existing knowledge, and deeper understandings are developed from, and take the place of, the earlier understandings. It is assumed that learning can be described and mapped as progress in the direction of qualitatively richer knowledge, higher-order skills, and deeper understandings. Vygotsky (1978) pointed out that pupils differ not only in terms of their actual developmental stage, i.e., the things a pupil can do independently, but also in their zone of proximal development, i.e., the distance between the actual developmental stage as determined by independent activity and the stage of potential development as determined by action under guidance or in collaboration with more capable peers.

Therefore, a person’s (i.e., teachers or pupils) ability to recognise the Vygotskyian (1978) zone of proximal development is fundamental to the identification of when that person should or shouldn’t intervene in the process of another person’s learning. In order to achieve this, developmental progressions have got to be established as teachers and pupils alike will be required to interpret evidence of learning to make intervention decisions and consider progress in a developmental model of learning. In turn, we can use this information to describe the stage of proficiency the pupil is most likely to have demonstrated in the process of learning. However, the challenge for teachers is to recognise pupils’ emerging skills and provide the right support at the right time at the right level. Therefore, teachers and peers alike need to be able to recognise the pupils ‘state of readiness’ in the domain of learning being mastered. This has implications for both teaching and learning. Traditionally, teachers are not trained to use evidence-based data to recognise a pupils’ stage of readiness to learn.

In view of that, this research recognises that in the use of learning protocols we can begin to create an environment where pupils can make their learning more visible. According to Hattie (2008) visible learning occurs when teachers get to see learning through the eyes of their pupils and help pupils become more aware of their learning. Hence, learning protocols can begin to evidence a pupils’ stage of readiness to learn, which allows us to then look at what pupils are beginning to know and understand, and work to nurture those emerging skills and abilities, rather than concentrating our attention retrospectively on those skills and abilities that have already been achieved.
2.5.4 Design of the Learning Environment

When a developmental model of learning is used, the teacher has to reorganise the classroom and manipulate the learning environment to meet the needs of individual pupils (Griffin et al. 2012). Manipulation of the learning environment is an important skill. The way in which a teacher links their classroom management, intervention strategies and resources used to facilitate learning is always a challenge. Just as a traditional educator may think of a ‘learning environment’ as simply the physical setting of tables and chairs within the classroom, so too do some teachers approach the notion of an ICT-supported learning environment as merely the technological infrastructure of mechanical hardware, networked computers and software programs. In order to harness the pedagogical implications of various kinds of ICT systems and infrastructures that are available these need to be reconciled, approached and understood in terms of constructivist learning principles which not only go beyond conventional transmission models of teaching and learning but actively encourage and seek to promote more effective ways of teaching and learning (Richards 2006).

In general, traditional practice allows for education and instruction to be delivered in a physical classroom setting and the current practices of online and blended learning allows for education and instruction to be delivered primarily via the internet in a virtual classroom setting, or in part via the internet in a virtual classroom setting with some element of a physical classroom setting. However, as more and more schools are continuing to install wireless broadband systems and pupils’ access to mobile technology becomes increasingly more ubiquitous (Williams & Kimbell 2012), the historical impediments to the delivery of online learning are rapidly disappearing and the lines between physical and virtual settings are becoming increasingly blurred. Therefore, with the latest advancements in ICT and cloud-based software, education and instruction are no longer confined to a classroom setting as new configurations for the delivery of education and instruction are now possible in almost any conceivable setting. This on-going development of ICT not only changes our methods of communicating and accessing information but creates new spaces for learning and new modes of interaction that challenge the limitations of the well-founded understanding of classical interaction; one user–one computer–one setting. Klokmose (2006) defines this new form of interaction as ubiquitous interaction (UI)
and this new kind of learning as ubiquitous learning (UL), U-Learning or uLearning. UL is considered a new trend in ICT that has emerged from ubiquitous computing. The term **ubiquitous computing** as coined by Weiser (1991) is described as technology that recedes into the background of our lives. With the combination of various computational technologies Weiser’s vision allows users to exchange information and services anytime, anywhere. This is an image of computing power invisibly embedded in the world around us and accessed through intelligent interfaces. Its role is to make computing so embedded, so fitting, so natural, that we use it without even thinking about it. This shift is about human-centred computing where technology is no longer a barrier, but works for us, adapting to our needs and preferences and remaining in the background until required (Ley 2007). UL is characterised by multiplicity; there is no one-to-one relationship between the user and the computer. There is not necessarily one single unified interface in a setting. Instead, one will see one-to-many or many-to-many relationships between the users, the computers, and the settings. Accordingly, UL has been defined as an educational paradigm within the context of a ubiquitous environment that provides the right support, in the right time and place, at the right level (Yahya, Ahmad & Jalil 2010).

UL presents schools with the capacity to extend learning beyond the ‘classroom’ setting which allows pupils to “construct their learning through their environment and at their individual learning rates” (Brown 2004, p. 36). This enables the development of a ubiquitous learning environment (ULE) whose borders are only limited by the imagination of those who participate within them, blurring the traditional institutional, spatial and temporal boundaries of schooling (Cope & Kalantzis 2008). ULE’s establish a hybrid setting which allows education and instruction to be delivered traditionally and/or via the internet by seamlessly embedding virtual presence into the physical classroom. A ULE can be described as an educational setting which connects teachers and pupils and is enhanced by technological devices with embedded user systems and dynamic interfaces. In view of this, UL is best suited to an adaptive educational transaction which focuses on the cognitive interplay of teachers and pupils and is situated in the context of socially-mediated activity. However, it is important to note that the design of the adaptive educational transaction ought to be generated from the learning processes and the outcomes of the particular discipline rather than from the capacity of the technology.
2.5.5 Delivery of the Educational Transaction

In addition to the design of the learning environment, the delivery of an adaptive educational transaction focusing on the cognitive interplay of teachers and pupils, situated in the context of socially-mediated activity is vital for supporting discourse. Hence, educational transactions should be designed to facilitate design-based activity due its strong affiliation with the development of social and cognitive competencies. Further, the CoI model follows a constructivist-collaborative perspective (Garrison et al. 2000) that is conducive to the pedagogy of design-based education (Barber 2011), which supports the design, facilitation and direction of social and cognitive processes to evidence a personally meaningful and educationally worthwhile learning process. Therefore, the delivery of an adaptive educational transaction requires some form of guidance document related to the processes and conditions for supporting discourse.

The Assessment and Teaching of 21st Century Skills (ATC21S) project has produced empirically derived progressions of both social and cognitive skills for collaborative problem-solving (CPS) in ICT-supported learning environments (see Appendix 3). According to Griffin, Woods, Mountain and Scoular (2013) these developmental progressions represent typical pathways of learning identified for teachers and pupils undertaking collaborative problem solving in ICT-supported learning environments, and can therefore be used as a guide for the delivery of the educational transaction. These guides help teachers to plan for instruction and organise their class, and they help pupils to understand where they have reached on each one of the progressions. Teachers can use the information they provide about the expected emergence of skills and understanding to plan on a developmental continuum to decide what aims and objectives to set for pupils, what types of experiences or materials they should provide, and how to challenge their pupils with interesting and achievable materials. If, for example, the guides used indicated that a pupil is currently working at learning stage two in social competence and stage one in cognitive skills, the teacher can use this information to plan pedagogical interventions and design appropriate learning experiences to move the pupil onto the next stage of social or cognitive development. The teacher can also refer to the current learning readiness of all pupils in the class, and make decisions about ways to organise small group learning experiences and/or provide opportunities for coupling less able pupils with more able pupils for support.
2.6 Summary

In the context of technology-mediated communication, to get a critical understanding of supporting discourse in second level education, the literature review focused on the context and environment for supporting discourse, the processes and conditions for supporting discourse, and the relationship between the processes and conditions. Hence, the literature review informing this study focused on the following key areas.

As previously mentioned, the nature of D&T education is both a pedagogically and technologically rich context for supporting discourse within second level education. Though difficult to provide evidence of the iterative process of teaching and learning in D&T, e-portfolios are being used in the assessment of pupil-content interactions. However, to support both the teacher-pupil and pupil-pupil interactions which define the social nature of D&T education requires an ICT-supported learning environment.

The pertinent research is characterised by the awareness that ICT does not transform learning, and that effective practice is far more pedagogical than it is technological. Accordingly, the technological pedagogical and content knowledge (TPACK) model highlights the important role ICT has in enhancing pedagogical content knowledge. However, in the context of technology-mediated communication, the TPACK model does little to inform the processes for supporting discourse for teaching and learning.

In light of this, the research investigation focused on the CoI model and in particular, on the processes of social, cognitive and teaching presence for supporting discourse. However, the context of these processes is set in online learning in higher education it was therefore necessary, for this research, to investigate the relationship between the processes and the conditions for supporting discourse in second level education.

These conditions forced the research to consider the ‘space’ for supporting discourse, as there are numerous restrictions around teaching and learning that would influence where and how discourse is supported. For that reason, this research acknowledges the need to create an additional ‘space’ or dimension for teaching and learning that goes beyond the traditional institutional, spatial or temporal boundaries of schooling. This forced the research to recognise the need for an overarching conceptual model.
3 Research Methodology
3.1 Methodological Approach

The social and educational reality of teaching and learning is a complex place, full of richness, involvedness and connectedness. Accordingly, classroom-based research is multi-layered and not easily susceptible to the atomisation process inherent in much laboratory-based research. Therefore, if a true understanding is to be reached it must be examined in the context of the whole rather than in fragments (Cohen et al. 2011).

This research could affect classroom variations without technology, or introduce technology without attending to the curriculum, etc. However, given the systemic nature of the environment simple controls can never be entirely satisfactory but they can provide insight into the operation of some of the major variables. Nonetheless, a ‘Hawthorne effect’ is presumed to transpire, explicitly increased social and cognitive productivity under the control of the pupils and with support from the technology. This presented a number of complexities when devising a suitable approach for investigating the use of TMC within the classroom setting. However, in an effort to capture the authenticity of the real world of teaching and learning a design experiments approach was identified as being an appropriate strategy (Brown 1992).

3.1.1 Method: Design Experiments

Though Cohen et al. (2011) acknowledge that a design experiments or design study approach does not conform to the requirements of a conventional experiment (e.g. it does not have the hallmarks of a randomised controlled trial), it does involve a deliberate and planned intervention, much like a conventional experiment. Brown (1992) suggests that design studies attempt to “engineer innovative educational environments and simultaneously conduct experimental studies of those innovations” (p. 141). The attraction and suitability of the approach is that it takes account of the complex, multivariate, real world of teaching and learning. Brown (1992) recognises that design studies are bought at the price of tidiness but justifies this in terms of the real world being “rarely isolatable, in terms of its components”, and in which “the whole really is more than the sum of its parts” (p. 166). As such, design studies are ‘messier’ than conventional experiments, as they take account of many variables and contexts as the intervention develops and changes over time to ensure what works at the design stage really works in practice (Gorard et al. 2004).
Figure 3.1 shows the complex features of design experiments adapted from Brown (1992). Central to this model is that the classroom must function smoothly as a learning environment before studying anything other than the many possible ways that things can go wrong. According to Brown (1992), classroom life is synergistic. Aspects of it that are often treated independently, such as teacher training, curriculum selection, testing and so forth actually form part of a systemic whole. As it is “impossible to change one aspect of the system without creating perturbations in others, so too it is difficult to study any one aspect independently from the whole operating system” (p. 143), we are responsible for simultaneous changes in the system, concerning the role of teachers and learners, the place of technology, the type of curriculum and so forth. These are all seen as inputs into the working whole.

![Diagram of Complex Features of Design Experiments](image)

**Figure 3.1 The Complex Features of Design Experiments (Brown 1992)**

Similarly, this research is concerned with outputs from the system which look at new forms of assessment. As Brown (1992) suggests, it’s necessity to assess the features of the learning environment that it was intentionally set up to foster, such as problem solving, critical thinking and reflection. Assessment further allows this research to be accountable, not only to the school authorities but to the teachers and pupils as well.

Additional tension in the approach rests between contributing to a theory of learning, a theoretical aim that is a cornerstone of this research, and contributing to practice.
For this to be true, the research must operate under the constraint that an effective intervention should be able to migrate from the experimental classrooms to traditional classrooms, maintained with feasible technological and personal support. Cobb et al. (2003) suggest that contributing to a theory of learning is a key feature of design studies; they are “crucibles for the generation and testing of theory” (p. 9), their purpose is to “generate theories of teaching and learning” (p. 10), and this involves development, intervention and reflection. In having “pragmatic roots” (p. 10), Cobb et al. (2003) directs us to suggesting the affinity between design studies and mixed methods research. This opinion is further echoed by Gorard et al. (2004), who suggests the design experiment itself does not offer a formal procedure for the combination of different sorts of data, within and between the studies various phases. And so, design experiments should include a mixed methods approach for the formal and rigorous combination of qualitative and quantitative data for potential solutions.

3.1.1.1 Approach: Mixed Methods

Shavelson et al. (2003) have suggested that key principles of design experiments are: iterative, process focused, interventionist, collaborative, multileveled, utility oriented and theory driven. To this Shavelson et al. (2003) indicated that design experiments can address research that asks: ‘What is happening?’, ‘Why or how is it happening?’ and ‘Is there a systematic effect?’. Therefore, Shavelson et al. (2003) suggest that longitudinal narrative data (e.g. audio recordings, transcript analysis) is particularly useful as it can track both developments and casual developments over time in order to capture the complexity and contextualisation of the planned research intervention. The difficulty lies in balancing a commitment to capture the diversity, variability, creativity, individuality, uniqueness and spontaneity of classroom interactions with a commitment to educational research methods to seek regularities, order and patterns. Accordingly, the data collected should facilitate the generation of ‘thick descriptions’ (Ceertz 1973), particularly of social processes, cognitive functions and behaviours, in tandem with measuring perceptions in order to understand the dynamics of TMC. A mixed methods approach was chosen for this research as the nature of the analysis would need to focus on both qualitative and quantitative data. Figure 3.2 summarises both the relevant qualitative and quantitative approaches of data collection that were combined in the mixed methods approach of compiling and analysing research data.
Each of these data sets will be elaborated on chronologically in subsequent sections.

### 3.2 Research Participants

According to Brown (1992) when research studies have taken place in naturally occurring groups situated in classroom settings, the pupils varied considerably in their ability, teachers were no longer experienced classroom managers, they had less control of time and procedural reliability became a constant problem. Control groups were difficult to engineer because of resource limitations and even ethical problems. Inherently, these ‘naturalistic’ studies are particularly confounded and it would take enormous resources to ‘unconfound’ them, even if this were hypothetically possible. In the light of this, consider the environment that this research is trying to engineer. This includes supporting discourse between teachers and pupils, generating a common language of progression, extending learning beyond the classroom, developing social-cognitive activity, establishing a classroom ethos where individual responsibility and group collaboration are the norm and so forth. Accordingly, this study will naturally intervene in various dimensions of classroom practice. The desired participant structures of this research intervention would require fundamental changes in the roles of both teachers and pupils, disrupting ‘practice as usual’, and historically teachers have been resistant to such classroom disruptions (Brown 1992).
The success of any technological initiative is substantially influenced by two major aspects: technical skills and positive attitude (Zhao, Pugh, Sheldon & Byers 2002). The significance of these components is related to in-service teachers being digital immigrants (Lei 2009). Firstly, teachers do not have the knowledge, skills and experiences that are necessary for teaching with technology because they did not grow up with technology and were not taught with technology (National Council for Accreditation of Teacher Education 1997; Office of Technology Assessment 1995; Prensky 2001; Rosenthal 1999). Secondly, teachers often hold negative attitudes and are sceptical about the use of technology for teaching (Bahr, Shaha, Farnsworth, Valerie & Benson 2004). In general, the image of teachers in relation to technology has not been very positive and are characterised as being reluctant and unwilling to integrate new technologies (Eteokleous, 2008; Macmillan, Timmons & Liu 1997). Smarkola (2007) found that experienced teachers depended on having both resources and personal support from school administrators to successfully integrate technology into their classroom. Furthermore, professional development studies have showed that in-service teachers believed that they would require training on how to better integrate ICT into their pedagogical practices to effectively facilitate teaching and learning (Bliss 2003; Driscoll 2001; Schnackenberg, Luik, Nisan & Servant 2001).

In contrast, pre-service teachers are commonly referred to as digital natives. As a generation of people born in the digital age, pre-service teachers have grown up with technology, are proficient in using technology and feel confident with technology. Additionally, having used more technology in both their learning as students and being exposed to different ideas about teaching with technology, pre-service teachers have the knowledge, skills and experiences to integrate technology into classrooms in meaningful ways that can help them teach and help their pupils learn (Lei 2009). According to Teo (2009), pre-service teachers engage in more volitional uses of ICT than practicing teachers and the former are not exposed to the same demands as practicing teachers in terms of their use of ICT from within and outside their professional environments. In this way, pre-service teachers have not been deterred by the ‘perceived usefulness’ of integrating technology in a real classroom setting. Central to the implementation of this study was the recruitment of teachers with the relevant knowledge, skills and experience to design the learning environments and deliver the educational transactions necessary to investigate the research questions.
Thus, in support of the emerging views expressed by Lei (2009) and Teo (2009), and in an effort to reduce variability among the integration of the technological approach pre-service teachers are, therefore, most suited for participation within this research. Although this could suggest an inability to generalise findings to in-service teachers, the findings can inform professional development or training for in-service teachers and enables this research to focus on the development of the pedagogical approach.

3.2.1 Sampling Criteria for Teachers

Technological Pedagogical Content Knowledge (TPACK) is based on an argument that pedagogically sound applications of technology requires the effective integration of teachers knowledge of content, pedagogy and technology as one single element, rather than viewing each of these elements as an individual domain of knowledge. Thus, since TPACK emphasises complex interactions among each of these elements, it was critical to ensure that participating teachers developed a firm base of TPACK. Thus, TPACK as a precursor for supporting discourse is a limitation of the research. To develop TPACK, initial teacher educator programmes employ authentic, design-based learning where pre-service teachers are engaged in solving problems through design processes (Angeli & Valanides 2005; Kearney 2006; Koehler & Mishra 2005; Koehler, Mishra & Yahya 2007). Koehler and Mishra (2005) and Koehler et al. (2007) used the ‘learning technology by design’ approach, describing it as a collaborative learning context in which pre-service teachers are engaged to become “a practitioner, not just learning about practice” (p. 135). Here design is both process and product, sensitive to the nature of particular subject matter. Thus, those who are participating in the design process need to rethink about the complex interplay of pedagogy and content and also affordances of technology to achieve their design goals. Koehler and Mishra (2005) report that participants who engaged in learning technology by design were able to move from seeing technology, pedagogy and content as separate constructs towards a more integrated and inter-related construct.

In conjunction with the Bachelor of Technology Education - NFQ Level 8 Honours Degree programme offered at the University of Limerick, 62 pre-service teachers (55 Male, 7 Female) engaged in a learning technology by design orientated module, supported by TMC and delivered over 12 weeks of their 3rd Year (Semester 6).
Based on their knowledge and understanding of TPACK in support of the subject discipline and its requirements, as well as their skills and attitudes towards ICT displayed throughout this module, 26 pre-service teachers (22 Male, 4 Female) were then invited (via email) to attend a briefing lecture, where they were provided with information about the research study and received a supporting information booklet. These pre-service teachers were also required to have used technology as students and not be deterred by the ‘perceived usefulness’ of using technology in a classroom. Subsequent to this briefing lecture, those wanting to integrate the proposed research intervention during their 4th Year (Semester 7) Teaching Practice School Placement were required to be teaching at least one class group within senior cycle education, specifically in D&T education where pupils will be engaged in design-based activity. Further, pupils in these class groups were required to have access to relevant ICT. The full list of sampling criteria for participating teachers is presented in Figure 3.3.

![Figure 3.3 Sampling Criteria for Research Participants](image)

Based on this criteria, 7 pre-service teachers (6 Male, 1 Female) were interested, and suitable, for participation within this research. The pre-service teachers ranged in age from 20 to 27 with a mean age of 22.29 years and a standard deviation of 2.29 years. In an effort to reduce any discrepancies in the design of the learning environments, to ensure that the practical skills and theoretical knowledge central to the delivery of the educational transactions was not undermined and since research has shown that pre-service teachers’ placement with a co-operating teacher was crucial in students’ educational technology preparation (Brent, Brawner & Van Dyk 2002; Doering et al. 2003; Willis & de Montes 2002), the pre-service teachers worked closely with the primary investigator and under the direct supervision of their co-operating school placement teachers, (all of whom have a minimum of 5 years classroom experience).
3.2.2 Sampling Criteria for Pupils

In collaboration with the pre-service teachers, their co-operating teachers and their associated schools, the research intervention was later integrated into 7 classrooms, with 7 groups of pupils who also met the sampling criteria as presented in Figure 3.3. Each of the participating schools are non-fee paying, co-educational, denominational and they each provide a broad range of academic, practical and vocational subjects. The schools are managed by boards of management which are representative of local interests and they are finically aided by the Department of Education and Skills. Based on the 2014/2015 key statistics publication, first published on 30th June 2015 (updated 7th July 2015) by the Department of Education and Skills, these schools are representative of approximately 72% of all pupils enrolled in second level education. The participating pupils in this study (n = 104) include 96 male and 8 female pupils. Although the female participants only make up 7.6% of the research sample, this is representative of the gender imbalance present in D&T education, where “boys far outnumber girls in the up-take of “practical subjects,” such as engineering, technical drawing and construction studies” (Department of Education and Science 2007, p.4). The Department of Education and Science (2007) noted that female pupils make up 4.7% of Engineering, 5.9% of Technical Drawing and 6.2% of Construction Studies candidates for examination (the lowest of all subjects) within senior cycle education. Nevertheless, ‘gender bias’ exceeds the limitations of this research, which focuses on supporting discourse using TMC in design-based activity in second level education. The pupils varied in age from 15 – 18 with a mean average of 16.35 and a standard deviation of 0.77. Table 3.1 shows the homogeneity of the participating class groups.

Table 3.1 Homogeneity of Participating Class Groups

<table>
<thead>
<tr>
<th>School</th>
<th>Cycle</th>
<th>(n)</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>S_01</td>
<td>Senior</td>
<td>20</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>S_02</td>
<td>Senior</td>
<td>24</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>S_03</td>
<td>Senior</td>
<td>20</td>
<td>18</td>
<td>2</td>
</tr>
<tr>
<td>S_04</td>
<td>Senior</td>
<td>7</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>S_05</td>
<td>Senior</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>S_06</td>
<td>Senior</td>
<td>11</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>S_07</td>
<td>Senior</td>
<td>17</td>
<td>15</td>
<td>2</td>
</tr>
</tbody>
</table>

Please note that full ethical approval for this research was granted from the University of Limerick, Faculty of Science and Engineering Ethics Committee, Reference: 2015_10_03_S&E – Appendix 1.
3.3 Research Intervention

With the aim of supporting discourse using TMC, the design and implementation of the pedagogical approach to be integrated was critical, as the most common pitfall in online learning is taking for granted that social interaction automatically takes place just because an environment makes it technologically possible (Kreijns et al. 2003). Moreover, Woo and Reeves (2007) suggest that not all interactions are meaningful. Only when the interaction has a direct influence on the learners’ intellectual growth can we say the interaction is meaningful (Hirumi 2002; Vrasidas & McIsaac 1999). Therefore, while it is essential that the design of the pedagogical approach focuses on the subject content it is also important to do so in ways that facilitates interaction. Hence, the design of the pedagogical approach was a key consideration in not only planning pupil-content interaction but also in directing and facilitating meaningful teacher-pupil and pupil-pupil interactions surrounding that content (Kanuka 2011).

As Figure 3.4 shows, this research identified three distinct factors which influenced the design and implementation of the pedagogical approach developed to support communication throughout the intervention: interaction, connection and transaction. Each of these factors will be elaborated on chronologically in the following sections.

![Figure 3.4 Factors Influencing the Design of the Pedagogical Approach](image-url)
3.3.1 Interaction: Generating a Common Language of Progression

When first considering using the CoI model as a framework for online and blended learning in second level education, it became apparent that the design, facilitation, and direction of social and cognitive processes would have a significant influence on supporting discourse. This led the research to consider the issue of: ‘What kind of evidence would support the development of social and cognitive processes in second level education to enhance practice?’, and thus ‘How can we devise a framework to ensure that such evidence is obtained and when obtained that it makes a difference?’

‘Evidence’ is a most contested term in schools, but what we do know is that it is in the language of teaching and learning and not assessment. It leads to discussions about the nature of teaching and learning and it provides information to help form school-wide conversations about ‘milestones’. Milestones are critical as they indicate the distance, i.e., zone of proximal development (Vygotsky 1978) between current and targeted progression and the manner in which to reduce this distance. Hattie (2005) maintains that if we can develop a model which provides diagnostic and formative evidence about these milestones then not only do we have an excellent model, we have one that enhances traditional practice in second level education. However, this begs the following question: ‘What is it is that we need to enhance?’

As previously discussed, the integration of ICT-supported learning must go beyond the simple transmission of knowledge towards transactional learning in support of the active construction of knowledge. Dewey’s (1938) transactional conception of activity-based education views experience as an educational transaction “taking place between an individual and what, at the time, constitutes his environment” (p. 43). This description not only fits neatly with the complex shifting of time and place that defines a CoI (Garrison et al. 2000) but emphasises the importance of interaction with the various people, content, and resources present in their learning environment. Hence, a model to enhance practice must be centred on the educational transaction.

The literature further suggested that experiential learning offers a holistic model of the learning that is a multi-linear model of learning and development, both of which are consistent with what we know about how we naturally learn, grow and develop.
Kolb (1984) believed that “learning is the process whereby knowledge is created through the transformation of experience” (p. 41). Kolb (1984) presented a cyclical model of learning consisting of four processes, each of which must be present for learning to occur most completely (see Figure 2.6). Kolb’s four-stage learning cycle demonstrates how experience is translated through reflection into concepts which in turn are used as guides for active experimentation and the choice of new experiences. Hence, these four stages could guide the learning around the educational transaction.

Furthermore, given that teaching presence is the design, facilitation and direction of social and cognitive processes for the purpose of realising personally meaningful and educationally worthwhile learning outcomes (Anderson et al. 2001). This research has argued that discourse must ensue around both learning processes and outcomes as this will inform the effectiveness of both teaching and learning. Accordingly, the literature has shown that Biggs and Collis (1982) SOLO taxonomy is a means of classifying learning outcomes in terms of their complexity. As a result this model can be used not only in the development of pupils’ learning in terms of its quality but in designing our pedagogical approach in terms of the learning outcomes. For this reason, it may be used as both an instructional, as well as an evaluation tool. Hence, this is helpful when implementing constructive alignment. As mentioned earlier, constructive alignment is a theory of learning that begins with the premise that individual learners create knowledge through relevant activity-based transactions much like experiential learning and is defined as the coherence between assessment, teaching strategies and intended learning outcomes within an educational transaction.

Therefore, since learning outcomes must have a sense of developmental progression, a common understanding between teachers and pupils about progression is possibly the greatest conduit to the enhancement of teaching and learning (Hattie 2005). While there is dialogue throughout activities and stories told about incidents, it is rare to hear discussions between teachers and pupils about levels of understanding or the degrees of knowledge required and attained. However, as social interactions are unlikely to occur without the provision of an instructional model that fosters them, the design and implementation of a pedagogical approach for supporting discourse necessitated the generation of a conceptual framework to help teachers and pupils articulate a common language of progression around the intended learning processes.
Respectively, by drawing on the key principles of Garrison et al. (2000), Kolb (1984) and Biggs and Collis (1982) this research has developed the Experiential, Procedural and Individual Model or *EPI Model* as a pedagogical approach to support discourse and demonstrate a shared understanding of the learning process and of progression. This EPI Model is presented as a conceptual framework for supporting discourse that provides diagnostic and formative evidence about the quality of pupil learning and the efficacy of teacher pedagogy through the development of the following elements: the design of the learning environment, the delivery of the educational transaction, and the experiential, procedural and individual domains of learning (see Figure 3.5).

![Figure 3.5 The EPI Model](image)

Hence, this research will conduct an exploratory study that investigates the use of the EPI Model to support discourse, in design-based activity, in second level education.

### 3.3.1.1 The Experiential Domain

It is posited that this domain which has an adaptive educational transaction at its core can begin to describe and map learning as an evidence-based progress through each stage within the domain (construct, capture, communicate, cogitate) which have been deduced from the stages of the experiential learning cycle (Kolb 1984). Cognisant of the direction of new knowledge which is linked to existing knowledge, where deeper understandings are developed from, and take the place of, earlier understandings.
The aim of this pedagogical approach is to move pupils understanding along a path of increasingly complex knowledge and skill by focusing on the pupils’ readiness to learn and building upon their current stages of understanding. As this process develops through the pupils’ practical activity and social interaction with others, it is the assumption of this research that by integrating the *Experiential Domain* we can begin to trace the complex and fundamentally non-linear nature of design-based activity, documenting both the individual and collaborative evidence of the pupils thinking and reflection processes displayed throughout the educational transaction.

### 3.3.1.2. The Procedural Domain

Procedural knowledge is the knowledge exercised in the accomplishment of a task and thus includes knowledge which, unlike declarative knowledge, cannot be easily articulated by the individual pupil since it is typically non-conscious (or tacit). Accordingly, this research classifies the *Procedural Domain* as individual processes of social and cognitive behaviour that evidence knowledge and understanding within a learning environment. In this domain we find a psychological state in which the pupils are trying to make sense of the Experiential Domain, i.e., how do pupils construct, capture, communicate and cogitate evidence of both their learning process and the outcomes of their learning throughout an adaptive educational transaction. Shown in Table 3.2 below, the Procedural Domain has been deconstructed into 12 learning protocols in a step towards the development of a common language of learning and progression regarding aspects of pupil knowledge and understanding.

**Table 3.2 Learning Protocols to Evidence Procedural Development**

<table>
<thead>
<tr>
<th>Process</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conceptualise</td>
<td>Creating a mental grasp of something to develop an idea or feeling.</td>
</tr>
<tr>
<td>Externalise</td>
<td>Giving abstract meaning to some or all elements of an idea or feeling.</td>
</tr>
<tr>
<td>Formalise</td>
<td>Applying tangible substance to practise or test an idea or feeling.</td>
</tr>
<tr>
<td>Analyse</td>
<td>Examining an idea or feeling in order to explain and interpret it.</td>
</tr>
<tr>
<td>Synthesise</td>
<td>Making what is known about an idea or feeling into a coherent whole.</td>
</tr>
<tr>
<td>Rationalise</td>
<td>Qualifying the importance or significance of a particular idea or feeling.</td>
</tr>
<tr>
<td>Generalise</td>
<td>Describing broad application, or conclusions from, an idea or feeling.</td>
</tr>
<tr>
<td>Hypothesise</td>
<td>Suggesting a possible explanation or direction for an idea or feeling.</td>
</tr>
<tr>
<td>Theorise</td>
<td>Reasoning supporting principles to substantiate an idea or feeling.</td>
</tr>
<tr>
<td>Revise</td>
<td>Looking over an idea or feeling in part or in full to correct or better it.</td>
</tr>
<tr>
<td>Reorganise</td>
<td>Changing the way in which an idea or feeling has been formulated.</td>
</tr>
<tr>
<td>Recognise</td>
<td>Knowing how to progress or reconstruct an idea or feeling.</td>
</tr>
</tbody>
</table>
Considering that these protocols can be used to describe pupils’ emerging skills it is fair to suggest that this is the kind of evidence that will support the development of effective teaching and learning within second level education and enhance practice. Therefore, in addition to providing informative data to evidence the relative efficacy of both the subject content and pedagogical methods that the teacher has delivered, this research argues that supporting discourse in the Procedural Domain augments the design, facilitation and direction of cognitive and social processes for the purpose of realising personally meaningful and educationally worthwhile learning processes.

3.3.1.3. The Individual Domain

Due to the complex and fundamentally non-linear nature of design-based activity both teachers and pupils can choose to operate within the proposed Experiential and Psychological Domains of the EPI Model in their own idiosyncratic manner. Therefore, a significant contribution that this research contributes to the current body of knowledge is the synergy connecting these domains. This is a novel approach to progress monitoring which takes account of the many variables and contexts as the educational transaction develops and changes over time. As a result of the integrated pedagogical approach this research proposes the Individual Domain in response to the physiological irregularity and unpredictable nature of social-cognitive activity. The individual domain provides a lens through which to consider the characteristic disposition of knowledge and understanding evidenced in the educational transaction and the multitude of learning styles present in the learning environment by providing the right support and the right feedback, in the right time and place, at the right level.

3.3.2 Connection: Extending Learning Beyond the Classroom

The second of three factors which influenced the design and implementation of the pedagogical approach for supporting discourse throughout the intervention concerns itself with establishing a ubiquitous connection for teaching and learning, enhanced by technological devices with embedded user systems and dynamic interfaces. This presents schools with the capability of extending learning beyond the classroom setting which allows the pupils to actively construct knowledge in their preferred environment, at their individual learning rate. Therefore, in view of current teaching resources for creating online communities of practice within second level education,
delivered by the Professional Development Service for Teachers (PDST) in Ireland, Edmodo was used. The context of Edmodo is not technological, it’s a pedagogical and collaborative medium that encourages a move away from an infrastructure heavy, technocratic learning environment where technology takes the centre stage (Wallace 2014). The reasons for choosing this specific learning platform rest with the instructional design and underlying ontology of the platform itself. Edmodo embodies a democratic approach with its organisational structure and takes an educational grassroots approach towards systems development and resource sharing (Wallace 2014). Edmodo also has administrative and organisational functionality which actually reflect the natural culture and interactions of classroom environments.

3.3.2.1 Edmodo: The Social Learning Network

In 2008, Edmodo was created by Nic Borg and Jeff O'Hara who realised the need to evolve the classroom environment to meet the connectedness of the 21st century world. The success of earlier social networking platforms like Facebook and Twitter showed Borg and O’Hara that pupils were connected in many ways outside the classroom but entered a void when they attended school (Gushiken 2013). Borg and O’Hara believed that a social network geared towards the needs of the pupils could have a profound impact on how they collaborate and learn in their world, rather than in the traditional classroom settings their teachers were educated in (Gushiken 2013).

MacArthur (2009) recognises that social networking is a unique place where pupils can develop communication skills with authentic audiences but reminds us that there are privacy and security concerns raised when using these technologies. However, Edmodo provides a training ground for safe and secure online behaviour (Holland & Muilenburg 2011) where teachers can easily monitor the kinds of information that pupils upload and provide useful feedback to support healthy communication skills. Holland and Muilenburg (2011) further suggest that by juxtaposing the informal nature of writing on the internet with formal assignments given by a teacher, pupils learn to think critically about the purpose of their communication. Hence, Edmodo is a free and secure learning network used to provide a simple way for teachers to create and manage online communities as well as enabling pupils to connect and work with their other classmates and teachers anytime, anywhere (Kongcham 2013).
3.3.2.2 Edmodo: User Accessibility and Privacy

Edmodo which is a form of social networking is commonly referred to as “Facebook for Education” (Enriquez 2014). The Edmodo interface has an appearance and navigation system that appears similar to Facebook and can be supported on various devices but instead of functioning with a recreational or social goal in mind, Edmodo promotes educational networking. The interface has been intentionally designed to create a sense of familiarity among users since most pupils have a Facebook account and to guarantee that it is user friendly (Balasubramanian, Jaykumar & Fukey 2014).

The difference between Edmodo and other social networks is that it is much more private and safe because it allows teachers to create and manage accounts for their pupils who receive a unique group code (Jarc 2010). Only those who receive this code can access and register in the group. No one else can participate in or observe the group. All communication is archived by Edmodo and no private chat is allowed.

3.3.2.3 Edmodo: At Home and in the Classroom

As there were strict policies relating to the use of mobile technologies during class time in each of the participating schools, the pedagogical approach necessitated a classroom setting where the pupils would have open access to Edmodo via stationary computers and supporting forms of ICT (e.g. webcams) during the regular class time.

Class settings typically came in two forms: peripheral settings and personal settings. Peripheral settings were those of contemporary D&T classrooms where pupils have the opportunities to work fluidly between traditional desks and stationary computers. Personal settings were that of typical computer rooms where pupils work exclusively on stationary computers. These rooms were normally used for specific ICT modules.

Although the participants’ access to Edmodo within the class was controlled by the environment, they had unrestricted access to it outside of the class on the mobile app. The mobile app provides a way for teachers to manage online interactions as well as enable pupils to connect with their classmates and teachers anytime and anywhere. This provided the capacity to extend learning beyond the classroom and for pupils to construct learning in their own environment and at their own individual learning rate.
3.3.3 Transaction: Developing Social-Cognitive Activity

In addition to the design of the learning environment, the delivery of an educational transaction which focuses on the cognitive interplay of teachers and pupils, situated in the context of socially-mediated activity was central to the pedagogical approach. Therefore, educational transactions were designed to facilitate design-based activity due its strong affiliation with the development of cognitive and social competencies. As mentioned earlier design-based activity is pupil-centred, in which the pupils learn about a subject through their experiences of solving design problems and includes problems that can be solved in more than one way and have more than one solution.

In an effort to control variability between the participating class groups and to create a sense of familiarity among the pupils, the educational transactions were structured around a standardised design-based activity as is normal practice in D&T education. As Figure 3.6 shows there are two distinct parts to the design assignment. Part (a) deals with the investigation, evaluation and representation of an existing object(s). This section is considered to be essential preparation for Part (b). Part (a) requires pupils to closely observe, examine and compare and contrast the design features of the object(s) while using various communication techniques to illustrate the functionality of the object(s). Part (b) is more about the actual process of designing, whether it is modifying existing design features of the object(s) in question or developing a completely new design solution to the brief. The success of Part (b) is dependent on the analysis and the research undertaken in completing Part (a). The example assignment as given to participating pre-service teachers is outlined below. Full details of transactions employed by this research are presented in Appendix 2.

Reusable water bottles are designed to provide hydration when participating in a range of activities. Their ergonomic design has resulted in a range of sleek, lightweight, compact, environmentally friendly and easy-to-use products. They are also often used for promoting commercial companies.

A. Carry out a design investigation of the physical form and features of existing water bottles. Your design investigation should include a brief exploration of reusable bottles over time.

and

A. Show graphically how you would physically modify the design of a reusable water bottle to improve its usage. Include an analysis of its shape, ergonomics, features, materials, etc.

or

Develop and graphically communicate a new concept design for a reusable water bottle based on a selected functional capacity or development aimed at a particular target market.

Figure 3.6 Design and Communication Graphics – Student Assignment (2014)
3.3.3.1 Delivering the Educational Transaction

The traditional approach to completing a design-based assignment, as is classroom practice in D&T education, requires the production of a paper-based A3 portfolio. The learning outcomes related to the design assignment will result in pupils being able to represent design and communication information through sketches, drawings, CAD and other ICT applications; use appropriate presentation techniques, including colour, rendering and sketching, to represent a design or artefact; analyse, evaluate and modify artefacts from a design perspective; generate appropriately dimensioned 2D and 3D drawings and models using CAD; and demonstrate visualisation skills. Accordingly, to support discourse using TMC around the nature of these learning outcomes a novel approach for the delivery of the design assignment was required. In an effort to document evidence-based progress during the educational transaction and practically integrate the proposed EPI framework as a pedagogical approach, both teachers and pupils were required to use Edmodo in conjunction with mobile technologies (e.g. smartphones, tablets, etc.), as well as stationary computers, to post matters associated with their process of learning and the product of their learning by:

- **Constructing** theoretical knowledge and practical skills as shared practice
- **Capturing** the learning process and evidence of their learning in real time
- **Communicating** a/synchronously with other participating group members
- **Cogitating** their learning process in collaborative and individual contexts

The structure of posts added to Edmodo was defined by each pupil to reflect the experience of their design process and represent the significance of their individual and collaborative approaches to forming solutions and showing evidence of learning. The nature of the data uploaded to Edmodo and the modes of representation used were at the discretion of the pupils and facilitated by Edmodo’s file sharing capacity, i.e., pupils could attach various text, image, audio or video files and even share links.

Although participation time varied from 4 to 6 weeks, the educational transactions would be analysed and codified in terms of phases in the design-activity, not time. This would determine if the nature of supporting discourse changed from periods of induction, through periods of manipulation and resulted in periods of naturalisation.
3.3.3.2 Codifying the Educational Transaction

As discussed in the literature teachers and pupils have to work collaboratively and base their intervention strategies and decisions on evidence (what pupils do, say, make or write), rather than inference (what pupils know, understand, think or feel). The capacity to identify pupils’ current and targeted progressions is fundamental as to when a person should or shouldn’t intervene in the process of pupils learning. However, to do so properly can be difficult even for the most experienced teacher. For this to work both in theory and practice, for teachers and pupils alike to base their intervention strategies and decisions on evidence, protocols based on a common language of progression have got to first be established in order to support discourse. Accordingly, this research proposes that the 12 protocols of the Procedural Domain can be used to ‘code’ the posts and comments teachers and pupils add to Edmodo. The coding scheme developed for the purpose of this study is shown in Appendix 6.

A unique feature of Edmodo is the hash-tagging system which teachers and pupils have the option of integrating during the management of their posts and comments. While uploading their files to Edmodo pupils have the option to create a tag or link between specific pieces of data and the learning protocols of the Procedural Domain. The # symbol, called a hashtag, was used by both teachers and pupils to self-tag their individual and collaborative evidence posted as part of the educational transaction. Any one of the learning protocols could be assigned to a post or comment added to Edmodo by a teacher or pupil using a hashtag, e.g. #formalise. However, it was not mandatory to hashtag as this may cause pupils to tag work for the sake of doing so. This required each pupil to reflect on the data being uploaded and to communicate it in terms of how it related to their own development in the educational transaction. This provides an insight into the pupils’ perception of how they conceived and developed their ideas and feelings through the learning process (Seery et al., 2012). The process of working iteratively, collaborating with others, uploading subsequent data files (evidence) to Edmodo while adding hashtags to posts and comments allows both teachers and pupils alike to track, manage and record the complex and fundamentally non-linear nature of learning throughout the educational transaction. It should be noted that protocols were open to interpretation by teachers and pupils and to be used to guide learning, not followed as a chronological set of procedures.
3.4 Data Collection Methods

Creating an informed narrative around social, cognitive and teaching processes relies on the triangulation of multiple sources of data to confirm and corroborate findings. The triangulated framework of core data collection methods is shown in Figure 3.7.

**Figure 3.7 Triangulated Research Approach**

3.4.1 Qualitative Data

The nature of teaching and learning is complex, subjective and not easily susceptible to quantitative measurement, nor is this appropriate. Instead, by taking a more qualitative approach, teaching and learning can be studied by gathering meaningful information from those involved in the educational process which gives a richer, fuller description of the phenomenon of interest. Qualitative research is multimethod in focus, involving interpretive, naturalistic research approaches to its subject matter. Thus, qualitative researchers study things in their natural settings, attempting to make sense of or interpret phenomena in terms of the meanings people bring to them (Denzin & Lincoln 1994). Qualitative research involves the studied use and collection of a variety of empirical materials, e.g. observations, interviews, field notes, emails, online conversations, etc., that describe situations, regularities, themes, categories and meanings in individuals experiences. With the aim of informing the quality of pupil learning and the efficacy of teacher pedagogy it was critical that this research employed qualitative measures to filter out any external factors, allowing a comprehensive answer to be reached and for the results to be legitimately discussed.
3.4.1.1 Transcript Analysis

At its source, transcript analysis is an exploratory, qualitative methodology, even though frequencies are provided to gain a quantitative sense of ‘what happened’. Its implementation, however, requires that several methodological issues be resolved. The coding of transcripts is a challenge under the best circumstances, but many of the validity and reliability deficiencies can be mitigated with valid models, discrete categories and clear indicators. In the context of this being an exploratory study, by adopting the CoI coding scheme (Anderson et al. 2001; Garrison et al. 2001; Rourke et al. 1999), and the proposed EPI Model, transcripts were deductively analysed based on social, cognitive and teaching presence, and the development of learning processes. Full details of the coding schemes employed are shown in Appendix 11.

The second issue is the unit of analysis. Rourke et al. (1999) identified five units of analysis used in technology-mediated research: sentence units, paragraph units, message units, thematic units and illocutionary units. While there has been some discussion around this issue (Fahy, 2001; Garrison et al. 2006; Rourke et al., 1999), it remains a challenging decision influenced by the research questions and context. Since Edmodo inherently offers a message-based approach, this research used the posts and comments as the unit of analysis. This unit has important advantages. It is objectively identifiable unlike other units of analysis and multiple coders can agree consistently on the total number of cases. It produces a manageable set of cases. Finally, it is a unit whose parameters are determined by the author of the message.

The third issue is the level of coding (e.g., category or indicator). Transcript analysis, as described by Rourke and Anderson (2004), is time-consuming, and coding at the indicator level is difficult, often yielding poor reliability (Murphy & Ciszewska-Carr 2005). However, coding at this level may potentially yield a deeper understanding. Given that the processes of procedural development as presented as part of the EPI framework are located at an indicator level, it was imperative that this study analyse and code the elements of social, cognitive and teaching presence at their respective indicator levels for the purposes of comparability. It is worth noting that the use of these indicators as units of measure does not always allow clear cut boundaries between coding. The difficulty rests in the fact that there is often more than one
possible category for each message and more than one possible indicator for each
category (Garrison Cleveland-Innes, Koole & Kappelman 2006). This research
follows Rourke et al. (1999) and Lomicka and Lord (2007) in the coding of
indicators to ensure a complete tabulation of social, cognitive and teaching presence.

The final issue is objectivity and reliability. The main test of objectivity in transcript
analysis is inter-rater reliability, defined as the extent to which different coders, each
coding the same content, come to the same coding decisions (Rourke, Anderson,
Garrison & Archer 2001). Accordingly, this necessitated the recruitment of two
impartial research assistants. Both research assistants were postgraduate research
students with a background in technology education and were specifically trained by
the primary investigator. Training included participation in a 4 hour workshop that
dealt with the theoretical basis of the CoI model and the practical applications of
quantitative content analysis. In a second 4 hour workshop, the research assistants
coded a series of transcripts. This process helped them to further understand the
coding scheme and to familiarise themselves with the coding and negotiated
agreement process (Garrison et al. 2006). After the workshop, the research assistants
continued analysing transcripts (excluded from the final reliability test) until they
reached high inter-rater agreement with the primary investigator. The primary
investigator then analysed the entire transcript of the research intervention. The
research assistants were then randomly assigned 25% of postings to re-analyse them.

3.4.1.2 Performance Analysis

Creating an informed narrative around the development of both social and cognitive
processes rests on knowing what happened as a result of the educational transaction.
This can inform the efficacy of the teaching process and provide a source of data that
is accountable and evidences the relative efficacy of different intervention strategies.

Thus, as shown in Table 3.3, a standards-referenced measure of social and cognitive
problem solving was used to assess individual and collaborative evidence of the
tasks performed or competencies displayed throughout the educational transaction.
Using the stages of social and cognitive development empirically derived from the
ATC21s project (Griffin et al. 2013), this research evaluated the individual and
collaborative performances of pupils based on the posts, comments and data files uploaded to Edmodo. This was carried out after the transaction had been completed. Additional details of the ATC21s stages of progression are presented in Appendix 3.

Table 3.3 Progression of Social & Cognitive Development

<table>
<thead>
<tr>
<th>Stage</th>
<th>Social Development</th>
<th>Cognitive Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Cooperation and Shared Goals</td>
<td>Refined Application and Problem Solving</td>
</tr>
<tr>
<td>5</td>
<td>Appreciated and Valued Partnership</td>
<td>Efficient Working</td>
</tr>
<tr>
<td>4</td>
<td>Mutual Commitment</td>
<td>Strategic Planning and Executing</td>
</tr>
<tr>
<td>3</td>
<td>Awareness of Partnership</td>
<td>Sharing and Connecting Information</td>
</tr>
<tr>
<td>2</td>
<td>Supported Working</td>
<td>Establishing Information</td>
</tr>
<tr>
<td>1</td>
<td>Limited Interaction</td>
<td>Exploration</td>
</tr>
</tbody>
</table>

Combining the results of the observational monitoring and the performance analysis methods of data collection we can begin to understand pupils’ social and cognitive development in terms of ‘what happened’ at each stage of the research intervention.

3.4.1.3 Pupil Focus Groups

Following the completion of the educational transaction, semi-structured focus groups were conducted to evaluate the pupils’ response to the research intervention. Based on the observational monitoring of participants Edmodo activity, topics for discussion were generated around ‘what happened’. The purpose of the focus groups was to gather a qualitative insight into the pupils’ perceptions of ‘why it happened’. Perception is regarded as the primary psychological activity since our perceptions give rise to what we do, think and feel and therefore perceived meaning is even more important than the objective reality, facts or events (Barker, Pistrang & Elliott 2002).

Questions were designed to gauge how pupils felt about discourse in their everyday learning being supported by ICT, if the discourse supported by ICT was different from the discourse in the classroom, if discourse supported by ICT is appropriate for design-based activity, if discourse supported by ICT influenced their learning and the evidence of their learning, and how well the pupils thought they were able engage in discourse supported by ICT. A total of seven focus groups were conducted; one from each class group participating in the study. For more details of the focus groups and guiding questions see Appendix 5 and for associated transcriptions see Appendix 15.
3.4.1.4 Teacher Interviews

Pre- and post-study teacher interviews were conducted to evaluate the design of learning environments and the delivery of educational transactions at the beginning of, and as a result of, the exploratory research study. The use of pre- and post-study interviews contributes to the generation of longitudinal narrative data, i.e., beginning and end, and can help evaluate the developments and casual developments over time in order to capture the complexity and contextualisation of the research intervention.

3.4.1.4.1 Pre-Intervention

After the preliminary intervention lesson and having registered pupils on Edmodo, semi-structured interviews were conducted in each school to explore the teachers’ technological and pedagogical approaches to integrating the educational transaction. The purpose of the interviews was to consolidate teachers understanding of ‘what is going to happen’. Questions were designed to evaluate the steps taken to support the integration of ICT in their classroom practice, and to benchmark the teachers’ initial perceptions, challenges and recommendations associated with integration of the ICT.

3.4.1.4.2 Post-Intervention

A post-intervention interview was conducted in an effort to explore ‘what happened’. The follow-up interviews conducted in each school involved retrospective reporting of the research intervention. The use of a stimulated recall framework was adopted as it was deemed most appropriate to the research questions. Stimulated recall safeguards against possible biases in teachers’ reflection on the actual events. It does this by presenting teachers with a more objective account of their actual behaviour during the intervention. Additionally, it provides a suitable time-frame for teachers to reflect on the intervention study, allowing for the consolidation of thoughts (Maquet 2001).

Additional questions were designed to evaluate the teachers’ perception of the pupils’ response to the research intervention. Based on the topics discussed in the focus groups around ‘what happened’, teachers were asked a similar set of questions in an effort to compare the pupils and teachers understanding of ‘why it happened’. Questions were meant to gauge how teachers felt about discourse in their everyday teaching being supported by ICT, if the discourse supported by ICT was different
from the discourse in the classroom, if discourse supported by ICT is appropriate for design-based activity, if discourse supported by ICT influenced pupils learning and the evidence of their learning and how well they thought the pupils were able engage in discourse supported by ICT. Fourteen interviews were conducted in total; two with each teacher participating in this study. For details of the interview questions refer to Appendices 4 and 7, and for the associated transcriptions see Appendix 15.

3.4.2 Quantitative Data

Conventional experiments have often used post-study surveys to investigate reasons participants give for their behaviour (Coolican 2014) as survey results embellish the quantitative findings, adding explanatory meanings to teachers and pupils actions. Survey data can direct new explanatory hypotheses and new research to test them. The surveys deployed by this research were done so at the end of the educational transaction with the intention of investigating the nature and effect of the conceptual pedagogical, technological and methodological approaches to supporting discourse.

3.4.2.1 Community of Inquiry Survey

A group of CoI researchers from various institutions, with various expertise of the model developed the CoI Survey Instrument (Arbaugh et al. 2008; Swan et al. 2008). The resulting instrument was developed from measures that the group members had successfully used to measure individual presences in the CoI framework. It includes 9 items designed to measure social presence (3 for affective expression, 3 for open communication and 3 for group cohesion), 12 items designed to measure cognitive presence (3 for triggering events, 3 for exploration, 3 for integration and 3 for resolution) and 13 items designed to measure teaching presence (4 for design and organisation, 6 for facilitation of discourse and 3 for direct instruction). This measurement tool may be used for continued explication of concepts in the model and can serve as a ground for quantitative investigations in mixed methods research. Although the CoI survey was first proposed to guide research into online settings, Arbaugh et al. (2008) encourage exploratory works that use the CoI as the dependent measure in the implementation of emerging technologies within additional settings. Initial work in this area indicates the CoI may be rather effective in determining the impact of specific pedagogical approaches and technological applications (Ice 2008).
Though since the CoI survey instrument was developed for use in higher education, both a Flesch reading ease test and Flesch–Kincaid grade level test was conducted to indicate the reading difficulty of the CoI survey. Although they use the same core measures (word length and sentence length) they have different weighting factors. The results of the two tests correlate inversely, i.e., a text with a comparatively high score on the reading ease test should have a low score on the grade level test. In the Flesch reading ease test, high scores indicate material that is easy to read, low scores mark material that is difficult to read. Scores are interpreted as shown in Table 3.4.

Table 3.4 Flesch Reading Ease Test

<table>
<thead>
<tr>
<th>Score</th>
<th>School Level</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>90.0–100.0</td>
<td>5th Grade</td>
<td>Very easy to read. Easily understood by an 11-year-old student.</td>
</tr>
<tr>
<td>80.0–90.0</td>
<td>6th Grade</td>
<td>Easy to read. Conversational English for consumers.</td>
</tr>
<tr>
<td>70.0–80.0</td>
<td>7th Grade</td>
<td>Fairly easy to read.</td>
</tr>
<tr>
<td>60.0–70.0</td>
<td>8th &amp; 9th Grade</td>
<td>Plain English. Easily understood by 13- to 15-year-old students.</td>
</tr>
<tr>
<td>50.0–60.0</td>
<td>10th - 12th Grade</td>
<td>Fairly difficult to read.</td>
</tr>
<tr>
<td>30.0–50.0</td>
<td>College Student</td>
<td>Difficult to read.</td>
</tr>
<tr>
<td>0.0–30.0</td>
<td>College Graduate</td>
<td>Very difficult to read. Best understood by university graduates.</td>
</tr>
</tbody>
</table>

The standard CoI survey instrument revealed a reading ease score of 34.7 and indicated a college grade level, suggesting that it was too difficult for second level pupils to read. By taking conservative measures in an attempt to remain true to the original survey while staying relevant to the study at hand, the CoI survey instrument was modified accordingly. The modified survey instrument revealed a reading ease score of 60.0 and indicated a grade level of 8, suggesting that it would be easily understood by 13- to 15-year-old pupils. The surveys are presented in Appendix 6.

3.4.2.2 Procedural Domain Survey

In addition to the CoI survey, this research designed 12 supplementary questions in an effort to explore the pupils’ perceptions of how well they felt they were able to construct, capture, communicate and cogitate evidence of both their learning process and the outcomes of their learning throughout an adaptive educational transaction. Each survey item related to one of the learning protocols in the Procedural Domain. Responses to each of these survey items would prove significant when considering the particular hashtags that pupils assigned to their posts and comments on Edmodo.
3.4.2.3 Usability & Feasibility Surveys

In general, it is impossible to specify the usability of a system or approach, i.e., its fitness for purpose, without first defining who are the intended users of the system, the tasks those users will perform with it and the characteristics of the physical, organisational and social environment in which it will be used (Brooke 1996). However, it is possible to talk of some general classes of usability measure. The international standard ISO 9241-11 suggests that measures of usability should cover:

- effectiveness (the ability to complete tasks and the quality of those tasks)
- proficiency (the level of resource consumed in performing tasks)
- satisfaction (users’ subjective reactions to using the system)

In response to these requirements, a simple usability scale was developed by Brooke (1996). The System Usability Scale (SUS) is a ten-item Likert scale that can be used to give a global view of subjective assessments of usability. The SU scale is generally used after the participant has had an opportunity to use the system being evaluated but before any debriefing or discussion takes place. Respondents should be asked to record their immediate response to each item, rather than thinking about items for a long time. All items should be checked. If a participant feels that they cannot respond to a particular item, they should mark the centre point of the scale.

The SUS instrument was delivered to investigate the teachers’ overall response to the usability of the technological (Edmodo) and pedagogical approaches (EPI Model). SUS yields a single number representing a composite measure of the overall usability of the system being studied. Note that scores for individual items are not so meaningful on their own. To calculate the SUS score, first sum the score contributions from each item. Each item's score contribution will range from 0 to 4. For items 1, 3, 5, 7 and 9 the score contribution is the scale position minus 1. For items 2, 4, 6, 8 and 10, the contribution is 5 minus the scale position. Multiply the sum of the scores by 2.5 to obtain the overall value. SUS scores range from 0 to 100. The SUS is not diagnostic and will not indicate specific usability problems but it will provide an insight into how much work the approach needs. A SUS score above a 68 would be considered above average (Bangor, Kortum & Miller 2008; Sauro 2011). SUS results lower than a 68 indicates usability problems which should be addressed.
4 Findings
4.1 Analysis of the Research Intervention

Though all pupils \((n = 104)\) in the 7 participating schools volunteered to take part within the study and had initially signed-up and created their Edmodo profiles, approximately 84\% of pupils \((n = 87)\) actively took part in the research intervention (i.e. working iteratively on Edmodo, tagging posts and comments, collaborating with others and uploading subsequent data files (evidence) to complete the learning task). The remaining pupils \((n = 17)\) engaged in the classroom activity as normal practice. Table 4.1 shows the percentages of pupils who actively participated within the study and indicates that on average, pupil uptake across schools was approximately 86\%.

Table 4.1 Participant Uptake of Research Intervention

<table>
<thead>
<tr>
<th>School</th>
<th>Total Pupils</th>
<th>Active Pupils</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Pupils</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>S_01</td>
<td>20</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>S_02</td>
<td>24</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>S_03</td>
<td>20</td>
<td>18</td>
<td>2</td>
</tr>
<tr>
<td>S_04</td>
<td>7</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>S_05</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>S_06</td>
<td>11</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>S_07</td>
<td>17</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>104</td>
<td>96</td>
<td>8</td>
</tr>
<tr>
<td>A.M.</td>
<td>14.86</td>
<td>13.71</td>
<td>1.14</td>
</tr>
<tr>
<td>S. D.</td>
<td>7.24</td>
<td>6.58</td>
<td>1.57</td>
</tr>
</tbody>
</table>

The process of working iteratively on Edmodo by tagging posts and comments with learning protocols, collaborating with others and uploading data files as evidence, allowed this research to track, manage and record the complex and fundamentally non-linear nature of teachers’ and pupils’ activity during the educational transaction. A total of 794 online interactions were record via Edmodo throughout the duration of the research intervention. The interactions were comprised of teacher posts \((n = 50)\), teacher comments \((n = 87)\), pupil posts \((n = 302)\) and pupil comments \((n = 355)\). 364 files were attached by teachers \((n = 50)\) and pupils \((n = 314)\) to individual posts. These files typically included documents, presentations, images, graphics or videos. The total word count of all posts and comments by teachers and pupils was 16,542.

Figure 4.1 shows examples of posts and comments uploaded by participants in S_05.
Figure 4.1 Example of Post with Pupil & Teacher Comments
4.1.1 The Nature of Learning Protocols

As part of the research intervention and with the use of Edmodo’s hashtag system, both teachers and pupils had the option to create a link between specific pieces of data and the 12 learning protocols (LP) identified as part of the Procedural Domain. As Table 4.2 shows, individual codes (LP01 – LP12) and descriptions of each of these learning protocols have been generated for the purposes of coding and analysis.

<table>
<thead>
<tr>
<th>Code</th>
<th>Protocol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LP01</td>
<td>Conceptualise</td>
<td>Creating a mental grasp of something to develop an idea or feeling.</td>
</tr>
<tr>
<td>LP02</td>
<td>Externalise</td>
<td>Giving abstract meaning to some or all elements of an idea or feeling.</td>
</tr>
<tr>
<td>LP03</td>
<td>Formalise</td>
<td>Applying tangible substance to practise or test an idea or feeling.</td>
</tr>
<tr>
<td>LP04</td>
<td>Analyse</td>
<td>Examining an idea or feeling in order to explain and interpret it.</td>
</tr>
<tr>
<td>LP05</td>
<td>Synthesise</td>
<td>Making what is known about an idea or feeling into a coherent whole.</td>
</tr>
<tr>
<td>LP06</td>
<td>Rationalise</td>
<td>Qualifying the importance or significance of a particular idea or feeling.</td>
</tr>
<tr>
<td>LP07</td>
<td>Generalise</td>
<td>Describing broad application, or conclusions from, an idea or feeling.</td>
</tr>
<tr>
<td>LP08</td>
<td>Hypothesise</td>
<td>Suggesting a possible explanation or direction for an idea or feeling.</td>
</tr>
<tr>
<td>LP09</td>
<td>Theorise</td>
<td>Reasoning supporting principles to substantiate an idea or feeling.</td>
</tr>
<tr>
<td>LP10</td>
<td>Revise</td>
<td>Looking over an idea or feeling in part or in full to correct or better it.</td>
</tr>
<tr>
<td>LP11</td>
<td>Reorganise</td>
<td>Changing the way in which an idea or feeling has been formulated.</td>
</tr>
<tr>
<td>LP12</td>
<td>Recognise</td>
<td>Knowing how to progress or reconstruct an idea or feeling.</td>
</tr>
</tbody>
</table>

The emphasis was put on the pupils to identify what protocols they valued as being appropriate to evidence learning with a conscious effort being made by teachers not to impose any criteria or values external to the pupils own experience with the brief. Accordingly, the assignment of learning protocols was at the discretion of the pupils. Table 4.3 shows the density at which teachers and pupils assigned each of the 12 learning protocols to both posts and comments throughout the research intervention. As Table 4.3 shows, a total of 413 protocols were assigned to interactions ($n = 794$). However, of the 794 interactions that were recorded over the duration of the study, 347 of these interactions contained at least 1 protocol, which is approximately 44%. Hence, the remaining 56% of interactions ($n = 447$) had not been assigned protocols. A detailed analysis of the learning protocols assigned by both teachers and pupils reveals that on average, posts were assigned 0.82 ($SD = 1.04$) protocols by teachers and 0.65 ($SD = 0.66$) protocols by pupils, while on average comments were assigned 1.03 ($SD = 0.67$) protocols by teachers and 0.24 ($SD = 0.48$) protocols by the pupils.
Table 4.3 Density of Learning Protocols

<table>
<thead>
<tr>
<th>School</th>
<th>Teachers</th>
<th></th>
<th></th>
<th></th>
<th>Pupils</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Post</td>
<td>Comment</td>
<td>n</td>
<td>Post</td>
<td>Comment</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>S_01</td>
<td>1</td>
<td>14</td>
<td>44</td>
<td>13</td>
<td>29</td>
<td>15</td>
<td>102</td>
<td></td>
</tr>
<tr>
<td>S_02</td>
<td>1</td>
<td>1</td>
<td>11</td>
<td>24</td>
<td>56</td>
<td>27</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>S_03</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>18</td>
<td>34</td>
<td>2</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>S_04</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>7</td>
<td>36</td>
<td>28</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>S_05</td>
<td>1</td>
<td>3</td>
<td>11</td>
<td>5</td>
<td>20</td>
<td>0</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>S_06</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>9</td>
<td>13</td>
<td>14</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>S_07</td>
<td>1</td>
<td>11</td>
<td>19</td>
<td>11</td>
<td>8</td>
<td>0</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>41</td>
<td>90</td>
<td>87</td>
<td>196</td>
<td>86</td>
<td>413</td>
<td></td>
</tr>
<tr>
<td>A.M.</td>
<td>1.00</td>
<td>5.86</td>
<td>12.86</td>
<td>12.43</td>
<td>28.00</td>
<td>12.29</td>
<td>59.00</td>
<td></td>
</tr>
<tr>
<td>S. D.</td>
<td>0.00</td>
<td>4.85</td>
<td>15.27</td>
<td>6.63</td>
<td>16.20</td>
<td>12.12</td>
<td>29.86</td>
<td></td>
</tr>
</tbody>
</table>

As Figure 4.2 illustrates, each of the 12 individual LP were assigned to at least one post or comment by teachers and pupils using a hashtag over the course of the study. This shows LP10 (Revise) was the most used LP by teachers \((n = 34)\) and LP04 (Analyse) was used the most by pupils \((n = 101)\), while LP07 (Generalise) was used the least by teachers \((n = 4)\) and LP09 (Theorise) was least used by pupils \((n = 2)\). The significance lies in the relationship between the frequency of teachers and pupils use of protocols that shows evidence of an iterative and interactive learning process. As is apparent when looking at LP10 – LP12, the protocols assigned by pupils is the evidence of their learning process in response to the protocols assigned by teachers.
4.1.1.1 Agreement of Learning Protocols

In comparing the frequency of protocols assigned by participants and the researcher, Figure 4.3 shows there was a clear sense of hierarchical progression in the protocols.

![Figure 4.3 Frequency of Protocols Assigned by Participants & Researcher](image)

And, in comparing the agreement of protocols assigned by pupils and the researcher, Figure 4.4 reveals that pupils understanding of this ‘meta-language’ of progression increased and began to align with the researches understanding of learning protocols.

![Figure 4.4 Agreement of Protocols between Pupils & Researcher](image)
4.1.2 Discourse in the Community of Inquiry

The primary test of objectivity in qualitative content analysis is inter-rater reliability. Accordingly, this necessitated the recruitment of two impartial research assistants. Both research assistants were postgraduate research students with a background in technology education and were specifically trained by the primary investigator. Training included participation in a 4 hour workshop that dealt with the theoretical basis of the CoI model and the practical applications of quantitative content analysis. In a second 4 hour workshop, the research assistants coded a series of transcripts. This process helped them to further understand the coding scheme and to familiarise themselves with the coding and negotiated agreement process (Garrison et al. 2006). After the workshop, the research assistants continued analysing transcripts (excluded from the final reliability test) until they reached high inter-rater agreement with the primary investigator. The primary investigator then analysed the entire transcript of the research intervention. The research assistants were then randomly assigned 25% of postings to re-analyse them. A 90% agreement was achieved ($\text{Cohen's } \kappa = 0.88$). Research usually reports reliability figures in the .80 to .90 range. Research that is breaking new ground with concepts that are rich in analytical value may go forward with reliability levels that are somewhat below that range (Riffe, Lacy & Fico 1998).

As a result of using the message as the unit of analysis, unit reliability was 100%. For each message unit, the coders were required to evidence the following decisions: the message contains or does not contain indicators of social, cognitive and teaching presence or the procedural domain. This research followed Rourke et al. (2001) in the coding of such indicators in order to ensure complete tabulation of all instances. This allowed for each message to contain indicators of all four elements, none of the four elements, or combinations of some of the four elements. As Rourke et al. (2001) note, the raw number of instances, or the number of instances per message are both skewed by differences in the number of words per message unit. Therefore, in order to compare the frequency of instances across the different elements, coding density figures were calculated for each category, as described Rourke et al. Coding density is calculated by dividing the number of times an indicator occurs by the number of words and multiplying by 1000. This offers a more precise way of examining what percentage of messages posted during the study contained indicators of the element.
4.1.2.1 Frequency of Coding

A total of 3866 codes were assigned to all 794 interactions recorded by S_01 – S_07, which means that on average, each interaction was assigned 4.87 codes (SD = 2.69). Table 4.4 presents the total amount of learning protocols (LP), social presence (SP), cognitive presence (CP), and teaching presence (TP) codes assigned to each school. The total codes assigned per school ranges from S_01 (n = 1112) to S_07 (n = 196), which coincides with the interactions recorded by S_01 (n = 237) to S_07 (n = 32), and the weeks S_01 (n = 6) to S_07 (n = 4) participated in the research intervention. As Table 4.4 shows, social presence received the most amount of codes (n = 1202), which is approximately 31% of codes assigned to S_01 – S_07. The distribution of social presence in comparing individual schools (see Appendix 11), indicates that social presence ranged from 22% of activity in S_03 to 42% in S_06. In addition, social presence was the highest coded element in S_01, S_04 and S_06. However, the second most frequently coded element; learning protocols (n = 1100), which accounts for 28% of the codes, was the highest in S_02, S_03, S_05 and S_07. Contra to social presence, this ranged from 35% of activity in S_03 to 20% in S_06. Table 4.4 reveals that cognitive presence was assigned 26% of codes (n = 990), and was found to be the third most coded element in all schools, exclusive of S_03. Akin to learning protocols, this ranged from 30% of activity in S_03 to 20% in S_06. This may suggest a possible link between learning protocols and cognitive presence, or this may just be indicative of their similar nature of categorising pupil activity. Finally, the remaining 15% of codes (n = 574) was assigned to teaching presence. As Table 4.4 shows, this was the least frequently coded element in all the schools. The level of teaching presence ranged from 12% of activity in S_01 to 24% in S_07.

Table 4.4 Quantity of CoI & PD Codes Assigned by Element

<table>
<thead>
<tr>
<th>Code</th>
<th>S_01</th>
<th>S_02</th>
<th>S_03</th>
<th>S_04</th>
<th>S_05</th>
<th>S_06</th>
<th>S_07</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>LP</td>
<td>290</td>
<td>276</td>
<td>82</td>
<td>172</td>
<td>176</td>
<td>52</td>
<td>52</td>
<td>1100</td>
</tr>
<tr>
<td>SP</td>
<td>406</td>
<td>260</td>
<td>52</td>
<td>186</td>
<td>148</td>
<td>102</td>
<td>48</td>
<td>1202</td>
</tr>
<tr>
<td>CP</td>
<td>284</td>
<td>234</td>
<td>72</td>
<td>156</td>
<td>148</td>
<td>48</td>
<td>48</td>
<td>990</td>
</tr>
<tr>
<td>TP</td>
<td>132</td>
<td>116</td>
<td>32</td>
<td>96</td>
<td>110</td>
<td>40</td>
<td>48</td>
<td>574</td>
</tr>
</tbody>
</table>

In light of the perceived relation between learning protocols and cognitive presence, the research was led to consider the display trend of the codes assigned per school.
For example, as shown in Figure 4.5 the trend of codes assigned by element for S_01 to learning protocols and cognitive presence followed a near identical path over time. See Appendix 12 for the analysis of the trend of the assigned codes for S_02 – S_07.

![Figure 4.5 Display Trend of CoI & PD Codes Assigned by Element (S_01)](image)

Therefore, a correlational analysis was conducted between the CoI and PD codes. The results of this analysis which are presented in Table 4.5 clearly indicate there is a significant positive correlation between learning protocols and cognitive presence.

<table>
<thead>
<tr>
<th></th>
<th>LP</th>
<th>SP</th>
<th>CP</th>
<th>TP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Protocols</td>
<td>Pearson Correlation</td>
<td>-.251**</td>
<td>.829**</td>
<td>-.001</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.975</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>794</td>
<td>794</td>
<td>794</td>
<td></td>
</tr>
<tr>
<td>Social Presence</td>
<td>Pearson Correlation</td>
<td>-.289**</td>
<td>.419**</td>
<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>794</td>
<td>794</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive Presence</td>
<td>Pearson Correlation</td>
<td></td>
<td>-.075*</td>
<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.035</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>794</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teaching Presence</td>
<td>Pearson Correlation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).
Since pupils and teachers had the option to create a link between their interactions (i.e. hashtag) and the learning protocols identified as part of the Procedural Domain, it was necessary for the researcher to also codify the interactions from LP01 – LP12. For example, the extract presented below as taken from P_63 (S_05) was coded as:
giving abstract meaning to some or all elements of an original idea or feeling (LP02);
making what is known about that initial idea or feeling into a coherent whole (LP05);
suggesting the possible explanation(s) or direction(s) for that idea or feeling (LP08);
and, changing the way in which that idea or feeling had first been conceived (LP11).

This is my third sheet for my assist project. In this sheet I externalise the suggestions that were made by my fellow students on my last post. In my last post I was suggested to put in a design to stop the wheelchair to fall backwards and to make it easier to get the wheelchair over curbs, so I designed a bar at the back of the chair to stop it from falling. The other suggestions were to make the chair more comfortable and to show different designs of the modern day wheelchair. I sketched two designs of chairs that are mainly for comfort and other had bigger wheels so that the person can wheel the chair themselves. This sheet is all about others people’s views of the design and implementing their opinions to our design #externalise (P_63).

A total of 1100 LP codes were assigned to all interactions recorded by S_01 – S_07, which means on average, each interaction was assigned 1.39 LP codes ($SD = 1.27$). Table 4.6 shows the amount of LP codes assigned to each school by their indicator.

<table>
<thead>
<tr>
<th>Code</th>
<th>S_01</th>
<th>S_02</th>
<th>S_03</th>
<th>S_04</th>
<th>S_05</th>
<th>S_06</th>
<th>S_07</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>LP01</td>
<td>6</td>
<td>38</td>
<td>0</td>
<td>18</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>79</td>
</tr>
<tr>
<td>LP02</td>
<td>40</td>
<td>46</td>
<td>6</td>
<td>34</td>
<td>40</td>
<td>10</td>
<td>6</td>
<td>182</td>
</tr>
<tr>
<td>LP03</td>
<td>10</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>34</td>
</tr>
<tr>
<td>LP04</td>
<td>65</td>
<td>46</td>
<td>4</td>
<td>35</td>
<td>20</td>
<td>10</td>
<td>6</td>
<td>186</td>
</tr>
<tr>
<td>LP05</td>
<td>14</td>
<td>18</td>
<td>0</td>
<td>9</td>
<td>10</td>
<td>4</td>
<td>6</td>
<td>61</td>
</tr>
<tr>
<td>LP06</td>
<td>19</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>0</td>
<td>6</td>
<td>54</td>
</tr>
<tr>
<td>LP07</td>
<td>77</td>
<td>40</td>
<td>58</td>
<td>40</td>
<td>20</td>
<td>11</td>
<td>0</td>
<td>246</td>
</tr>
<tr>
<td>LP08</td>
<td>42</td>
<td>48</td>
<td>4</td>
<td>24</td>
<td>36</td>
<td>7</td>
<td>7</td>
<td>168</td>
</tr>
<tr>
<td>LP09</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>LP10</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>10</td>
<td>2</td>
<td>6</td>
<td>33</td>
</tr>
<tr>
<td>LP11</td>
<td>4</td>
<td>8</td>
<td>0</td>
<td>6</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>23</td>
</tr>
<tr>
<td>LP12</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>0</td>
<td>6</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>290</td>
<td>276</td>
<td>82</td>
<td>172</td>
<td>176</td>
<td>52</td>
<td>52</td>
<td>1100</td>
</tr>
<tr>
<td>A.M.</td>
<td>24.17</td>
<td>23.00</td>
<td>6.83</td>
<td>14.33</td>
<td>14.67</td>
<td>4.33</td>
<td>4.33</td>
<td>91.67</td>
</tr>
<tr>
<td>S. D.</td>
<td>25.72</td>
<td>18.89</td>
<td>16.26</td>
<td>15.21</td>
<td>12.30</td>
<td>4.31</td>
<td>2.77</td>
<td>80.83</td>
</tr>
</tbody>
</table>
The amount of LP codes assigned per indicator ranges from LP07 \((n = 246)\) to LP09 \((n = 15)\). As previously noted, LP07 (Generalise) and LP09 (Theorise) were the least frequent assigned self-codes used by teachers \((n = 4)\) and pupils \((n = 2)\) respectively. This may suggest teachers were aware of the amount of interactions being recorded as ‘generalised’ evidence of pupil learning and didn’t need to instruct pupils to do so, while pupils were aware that the evidence of their learning was not being ‘theorised’. In addition, Table 4.6 shows LP04 was the second most frequently coded \((n = 186)\), while LP04 (Analyse) was the most frequent assigned self-code by pupils \((n = 101)\). This further suggests that pupils, teachers and researchers use of codes was aligned. Figure 4.6 presents the frequency of LP codes assigned by indicator in S_01 – S_07.

![Figure 4.6 Frequency of LP Codes Assigned by Indicator](image1)

Using the frequency of LP codes assigned by indicator to calculate the percentage of codes assigned by category indicates that ‘communicating’ evidence of learning (LP07 – LP09) was assigned the most amount of LP codes (39%), while ‘cogitating’ the learning process (LP10 – LP12) was the least frequently coded (7%). The remaining 54% of codes were assigned evenly between ‘constructing’ evidence of learning (LP01 – LP03) and then ‘capturing’ the learning process (LP04 – LP06). The distribution of learning protocols in comparing individual schools (Appendix 8), suggests the more a school ‘communicated’, the less they ‘cogitated’ their learning, and indicates a relative association between ‘constructing’ and ‘capturing’ evidence.
In view of the fact that each of the learning protocols is located at the indicator level, it was necessary to also code the elements of social, cognitive and teaching presence at their respective indicator levels for the purposes of comparability in S_01 – S_07. Full details on each of the coding schemes employed are presented in Appendix 9.

Using indicators SP01 – SP12, the first CoI element to be coded was social presence. For example, the extract presented below as taken from T_06 (S_06) was coded as: conventional expressions of emotion (SP01); complimenting others or the contents of others’ messages (SP08); and the use of phatic expressions or salutations (SP12).

Hi all, I would like to thank everyone who had uploaded their work last night on time and put in an amount of effort engaging with Edmodo so far, (T_06).

A total of 1202 SP codes were assigned to all interactions recorded by S_01 – S_07, which means on average, each interaction was assigned 1.51 SP codes (SD = 1.21). Table 4.7 shows the amount of SP codes assigned to each school by their indicator. The amount of SP codes assigned per school ranges from S_01 (n = 406) to S_07 (n = 48) and codes assigned per indicator ranges from SP04 (n = 442) to SP05 (n = 4). The high level of codes assigned to SP04 is explained by the nature of the indicator: using the reply feature (i.e. comments), rather than starting a new thread (i.e. posts).

<table>
<thead>
<tr>
<th>Code</th>
<th>S_01</th>
<th>S_02</th>
<th>S_03</th>
<th>S_04</th>
<th>S_05</th>
<th>S_06</th>
<th>S_07</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP01</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>7</td>
<td>16</td>
<td>8</td>
<td>2</td>
<td>47</td>
</tr>
<tr>
<td>SP02</td>
<td>10</td>
<td>2</td>
<td>12</td>
<td>8</td>
<td>0</td>
<td>8</td>
<td>2</td>
<td>42</td>
</tr>
<tr>
<td>SP03</td>
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<td>4</td>
<td>5</td>
<td>2</td>
<td>4</td>
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<td>23</td>
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<tr>
<td>SP04</td>
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<td>111</td>
<td>25</td>
<td>74</td>
<td>38</td>
<td>40</td>
<td>14</td>
<td>442</td>
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<td>0</td>
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<td>4</td>
</tr>
<tr>
<td>SP06</td>
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<td>2</td>
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<td>22</td>
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<tr>
<td>SP07</td>
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<td>46</td>
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<td>5</td>
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<td>73</td>
</tr>
<tr>
<td>SP08</td>
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<td>51</td>
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<td>34</td>
<td>40</td>
<td>16</td>
<td>12</td>
<td>208</td>
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<tr>
<td>SP09</td>
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<td>0</td>
<td>1</td>
<td>0</td>
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<td>31</td>
</tr>
<tr>
<td>SP10</td>
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<td>2</td>
<td>40</td>
<td>29</td>
<td>6</td>
<td>10</td>
<td>183</td>
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<tr>
<td>SP11</td>
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<td>4</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>85</td>
</tr>
<tr>
<td>SP12</td>
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<td>4</td>
<td>4</td>
<td>6</td>
<td>3</td>
<td>12</td>
<td>6</td>
<td>42</td>
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<td><strong>Total</strong></td>
<td><strong>406</strong></td>
<td><strong>260</strong></td>
<td><strong>52</strong></td>
<td><strong>186</strong></td>
<td><strong>148</strong></td>
<td><strong>102</strong></td>
<td><strong>48</strong></td>
<td><strong>1202</strong></td>
</tr>
</tbody>
</table>

A.M. 33.83 21.67 4.33 15.50 12.33 8.50 4.00 100.17

S. D. 41.14 33.70 7.36 22.50 15.02 11.09 5.19 125.04
Exclusive of SP04, the indicators assigned the most codes were SP08 \((n = 208)\), i.e., complimenting others or the contents of others' messages (interactive), and SP10 \((n = 183)\), which is the addressing or referring to other participants by name (cohesive). Figure 4.7 presents the frequency of SP codes assigned by indicator in S_01 – S_07.

As Figure 4.7 illustrates, SP01 – SP03 which make up the affective category of social presence were assigned relatively low amounts of coding \((n = 112)\), which accounts for approximately 9% of all SP codes assigned to S_01 – S_07. The distribution of affective responses in comparing each schools (see Appendix 11), shows that affective interactions ranged from 3% of activity in S_02 to 38% in S_03. The low amount of codes assigned to the affective category of social presence, which includes the use of emoticons, humour, and self-disclosure, may suggest that because participants are by now familiar with, and have regular contact time with each other, TMC for social-emotional purposes is not as necessary in second level education.

The SP category to receive the most coding was the interactive category \((n = 780)\), which accounts for 65% of codes, and was the most coded category in S_01 – S_07. However, the interactive category (SP04 – SP09) does consist of six indicators while the affective and cohesive categories of social presence contain three indicators each. Finally, the remaining 26% of codes \((n = 310)\) was assigned to cohesive responses. As shown in Table 4.7, this category was reasonably well coded from S_01 – S_07.

![Figure 4.7 Frequency of SP Codes Assigned by Indicator](image-url)
The CoI element cognitive presence was coded using the indicators CP01 – CP15. For example, the extract presented below as taken from P_66 (S_06) was coded as: presenting background information (CP01); presenting different ideas in a message (CP04); adding to established points but not systematically defending or developing the addition (CP07); and lastly, connecting information from many sources (CP11).

In this sheet I explored the modern day wheelchair and how its design as well as its features improves the overall experience for its user. I explore the key components of comfort which have made the wheelchair better, such as the arm rests as well as seat itself. The footrests are also a pivotal part of the design as they offer the user comfort whilst also stabilising the chair. The chair itself is well-built, made from high-end aluminium and steel. The large wheels also give users the ability to move themselves #conceptualise, (P_66).

A total of 990 CP codes were assigned to all interactions recorded by S_01 – S_07, which means on average, each interaction was assigned 1.25 CP codes ($SD = 1.13$). Table 4.8 shows the amount of CP codes assigned to each school by their indicator. The amount of CP codes assigned per school ranges from S_01 ($n = 284$) to S_07 ($n = 48$) and codes assigned per indicator ranges from CP05 ($n = 333$) to CP13 ($n = 10$). Table 4.8 further shows that all CP13 codes were assigned exclusively to S_01.

<table>
<thead>
<tr>
<th>Code</th>
<th>S_01</th>
<th>S_02</th>
<th>S_03</th>
<th>S_04</th>
<th>S_05</th>
<th>S_06</th>
<th>S_07</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP01</td>
<td>8</td>
<td>12</td>
<td>0</td>
<td>8</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>38</td>
</tr>
<tr>
<td>CP02</td>
<td>28</td>
<td>36</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>75</td>
</tr>
<tr>
<td>CP03</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>CP04</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>26</td>
<td>15</td>
<td>10</td>
<td>0</td>
<td>55</td>
</tr>
<tr>
<td>CP05</td>
<td>102</td>
<td>82</td>
<td>62</td>
<td>30</td>
<td>25</td>
<td>14</td>
<td>18</td>
<td>333</td>
</tr>
<tr>
<td>CP06</td>
<td>22</td>
<td>13</td>
<td>0</td>
<td>10</td>
<td>6</td>
<td>0</td>
<td>8</td>
<td>59</td>
</tr>
<tr>
<td>CP07</td>
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<td>18</td>
<td>14</td>
<td>10</td>
<td>0</td>
<td>80</td>
</tr>
<tr>
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<td>10</td>
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<td>6</td>
<td>0</td>
<td>56</td>
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<tr>
<td>CP09</td>
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<td>2</td>
<td>5</td>
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<td>0</td>
<td>21</td>
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<tr>
<td>CP10</td>
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<td>7</td>
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<td>0</td>
<td>47</td>
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<tr>
<td>CP11</td>
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<td>3</td>
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<td>16</td>
<td>15</td>
<td>8</td>
<td>6</td>
<td>64</td>
</tr>
<tr>
<td>CP12</td>
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<td>25</td>
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<td>15</td>
<td>20</td>
<td>0</td>
<td>10</td>
<td>92</td>
</tr>
<tr>
<td>CP13</td>
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<td>0</td>
<td>10</td>
</tr>
<tr>
<td>CP14</td>
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<td>2</td>
<td>0</td>
<td>6</td>
<td>10</td>
<td>0</td>
<td>6</td>
<td>26</td>
</tr>
<tr>
<td>CP15</td>
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<td>0</td>
<td>10</td>
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<td><strong>Total</strong></td>
<td><strong>284</strong></td>
<td><strong>234</strong></td>
<td><strong>72</strong></td>
<td><strong>156</strong></td>
<td><strong>148</strong></td>
<td><strong>48</strong></td>
<td><strong>48</strong></td>
<td><strong>990</strong></td>
</tr>
<tr>
<td><strong>A.M.</strong></td>
<td><strong>18.93</strong></td>
<td><strong>15.60</strong></td>
<td><strong>4.80</strong></td>
<td><strong>10.40</strong></td>
<td><strong>9.87</strong></td>
<td><strong>3.20</strong></td>
<td><strong>3.20</strong></td>
<td><strong>66.00</strong></td>
</tr>
<tr>
<td><strong>S. D.</strong></td>
<td><strong>24.70</strong></td>
<td><strong>21.00</strong></td>
<td><strong>15.90</strong></td>
<td><strong>9.04</strong></td>
<td><strong>7.13</strong></td>
<td><strong>4.95</strong></td>
<td><strong>5.39</strong></td>
<td><strong>78.04</strong></td>
</tr>
</tbody>
</table>
This indicates that in all 794 interactions recorded during the research intervention S_01 was the only school to be seen applying their learning to real world situations. This is most likely a result of the practical educational transaction delivered by S_01. Table 4.8 further shows that SP05 was the highest coded indicator in all schools, which implies cognitive activity was mainly focused on the exchange of information. Figure 4.8 shows the frequency of CP codes assigned by indicator in S_01 – S_07.

![Figure 4.8 Frequency of CP Codes Assigned by Indicator](image)

Using the frequency of CP codes assigned by indicator to calculate the percentage of codes assigned by category (Appendix 11), indicates that exploration (CP03 – LP08) was assigned the most amount of CP codes (60%), while resolution (LP10 – LP12) was the least frequently coded (6%). The remaining triggering (CP01 – CP02) and integration (CP09 – CP12) categories received 11% and 23% of codes respectively.

The distribution of cognitive presence in comparing individual schools (Appendix 8) shows that when exploration was the highest level of activity recorded by a school, which it was in all schools, the level of resolution was either lowest or not present. This is similar to the distribution of learning protocols shown in (Appendix 11), suggested the more a school ‘communicated’, the less they ‘cogitated’ their learning. Again, this might suggest a link between learning protocols and cognitive presence, or this might just be indicative of their similar nature of categorising pupils activity.
Lastly, the teaching presence element was coded using the indicators TP01 – TP18. For example, the extract presented below as taken from T_05 (S_05) was coded as: setting curriculum (TP01); designing methods (TP02); acknowledging or reinforcing pupils’ contributions (TP08); and, focusing the discussion on specific issues (TP13).

Brilliant work over the weekend, I’m delighted to see you all interacting with each other and trying to influence each other’s designs. The next step of the assignment is to try and #externalise some of the suggestions made to you from your fellow peers. This is so you can develop a better understanding of the suggestions that were made. My advice here would be to approach this sheet as open minded as possible as this exploratory sheet may trigger your thinking in a possible direction to further develop your initial ideas, (T_05).

A total of 574 TP codes were assigned to all interactions recorded by S_01 – S_07, which means on average, each interaction was assigned 0.72 TP codes (SD = 1.07). Table 4.9 shows the amount of TP codes assigned to each school by their indicator. The amount of TP codes assigned per school ranges from S_01 (n = 132) to S_03 (n = 32) and codes assigned per indicator ranges from TP08 (n = 102) to TP18 (n = 2).

| Table 4.9 Quantity of TP Codes Assigned by Indicator |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Code    | S_01 | S_02 | S_03 | S_04 | S_05 | S_06 | S_07 | Total |
| TP01    | 4    | 2    | 2    | 4    | 10   | 4    | 4    | 30    |
| TP02    | 6    | 5    | 6    | 10   | 12   | 3    | 6    | 48    |
| TP03    | 0    | 2    | 2    | 4    | 4    | 2    | 2    | 16    |
| TP04    | 6    | 6    | 4    | 4    | 4    | 4    | 2    | 30    |
| TP05    | 6    | 1    | 0    | 2    | 0    | 3    | 0    | 12    |
| TP06    | 2    | 4    | 0    | 0    | 0    | 0    | 0    | 6     |
| TP07    | 2    | 2    | 0    | 0    | 0    | 0    | 0    | 4     |
| TP08    | 16   | 4    | 0    | 26   | 34   | 12   | 10   | 102   |
| TP09    | 4    | 6    | 0    | 4    | 0    | 0    | 2    | 16    |
| TP10    | 4    | 2    | 0    | 0    | 0    | 2    | 0    | 8     |
| TP11    | 6    | 0    | 0    | 0    | 0    | 0    | 0    | 6     |
| TP12    | 12   | 14   | 12   | 2    | 0    | 0    | 4    | 44    |
| TP13    | 10   | 8    | 0    | 14   | 16   | 2    | 4    | 54    |
| TP14    | 4    | 2    | 0    | 0    | 0    | 0    | 0    | 6     |
| TP15    | 22   | 28   | 0    | 12   | 20   | 4    | 6    | 92    |
| TP16    | 22   | 30   | 2    | 12   | 10   | 2    | 8    | 86    |
| TP17    | 4    | 0    | 4    | 2    | 0    | 2    | 0    | 12    |
| TP18    | 2    | 0    | 0    | 0    | 0    | 0    | 0    | 2     |
| Total   | 132  | 116  | 32   | 96   | 110  | 40   | 48   | 574   |
| A.M.    | 7.33 | 6.44 | 1.78 | 5.33 | 6.11 | 2.22 | 2.67 | 31.89 |
| S. D.   | 6.58 | 8.90 | 3.14 | 6.96 | 9.44 | 2.88 | 3.14 | 32.46 |
Table 4.9 further shows that both TP18 codes were assigned exclusively to S_01 which indicates S_01 was the only school that needed to respond to technical issues and suggests the technological approaches integrated by schools were not a concern. Additionally, TP08 which was the most frequently coded indicator, reveals teaching activity was mainly focused on acknowledging or reinforcing pupils’ contributions. Figure 4.9 presents the frequency of TP codes assigned by indicator in S_01 – S_07.

![Figure 4.9 Frequency of TP Codes Assigned by Indicator](image)

Figure 4.9 shows, TP12 – TP18 which make up the direct instruction category of teaching presence received the most amount of codes \((n = 296)\) which Appendix 11 shows, accounts for approximately 51% of all TP codes assigned to S_01 – S_07. The distribution of teaching presence in comparing individual schools (Appendix 11) shows that direct instruction ranges from 70% of activity in S_02 to 25% in S_06, which is the only school in which direct instruction was not the most coded element. The remaining codes were assigned between the design and organisation (24%) and the facilitating discourse (25%) categories of teaching presence. However, direct instruction consists of seven indicators while design and organisation (TP01 – TP05) and facilitating discourse (TP06 – TP11) contain five and six indicators respectively. Appendix 11 further illustrates that schools which integrated problem-based learning recoded higher percentages of facilitating discourse than schools which integrated content-based learning, who recorded higher percentages of design and organisation.
4.2 Evaluation of the Proposed Framework

To explore the relationship amid the Community of Inquiry and Procedural Domain the 46 item Community of Inquiry (34 items) and Procedural Domain (12 items) survey instrument was administered to pupils at the end of the research intervention. The survey administration platform utilised was a well-known online survey tool, which participants accessed by means of a URL provided by teachers via Edmodo. Of the 87 participating pupils, 77 pupils volunteered to complete the survey, yielding a response rate of 88.5%. The gender distribution of respondents was 97.40% male and 2.60% female. Ages ranged from 15 to 18 with an average of 16.35 ($SD = 0.77$).

Although the number of respondents is small (Cohen et al. 2011; Comrey, Lee, Comrey & Lee 1992; Nunnally 1978; Tabachnik & Fidell 2007; Tinsley & Kass 1979), results from the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy (0.76) and Bartlett's test of sphericity ($\chi^2_{1035} = 2873.068$, $p < .000$) indicated the data was appropriate for factor analysis and should yield distinct and reliable factors. Ordinal responses were measured using a five-point Likert scale ($1 =$ Strongly Disagree to $5 =$ Strongly Agree). Descriptive statistics including means, standard deviations, skewness and kurtosis of the four elements of the CoI and PD survey instrument are shown in Appendix 12. Mean responses for the 46 items ranged from 3.65 for Item 13 (I used a variety of information sources to explore problems posed in this class) to 4.38 for Item 6 (I felt comfortable talking with the other pupils in the class). Standard deviations were highest for Item 13 ($SD = 1.11$), and lowest for Item 5 ($SD = 0.76$) (I felt comfortable joining in the class discussions) and Item 6 ($SD = 0.76$). When considering all respondents’ ratings, social presence items collectively yield a mean score of 4.05 ($SD = 0.89$), cognitive presence items collectively yield a mean score of 3.89 ($SD = 0.91$), teaching presence items yield a mean score of 4.17 ($SD = 0.95$), and the procedural domain items yield a mean score of 4.01 ($SD = 0.94$). In addition, the data utilised in this study was found to normally distributed as both the degrees of skewness (-0.92) and kurtosis (0.68) are less than the absolute value of 1. The results from each of the independent variables within the 42 item CoI and PD survey were compared by Pearson’s correlation coefficient (Appendix 12). The reliability of the CoI and PD instrument was measured using Cronbach’s Alpha which revealed the coefficient alpha $\alpha = 0.96$, suggesting high internal consistencies.
4.2.1 Community of Inquiry Survey

An initial Exploratory Factor Analysis (EFA) in SPSS version 22.0 was conducted, first using the results from the 34 CoI survey items with direct oblimin rotation and no limitation on the number of factors to extract, to identify the factors in the data. The EFA yielded seven factors with eigenvalues > 1. However, the respective scree plot (Figure 4.10) fails to inform the possibility of the fifth, sixth and seventh factors given the noticeable decrease in magnitude after the initial four factor's eigenvalues. This factor structure accounts for 58.73% of the total variance in respondent scores. The percentages explained by each factor are 36.67% (Cognitive Presence), 10.70% (Teaching Presence), 5.89% (Affective), and 5.46% (Interactive and Cohesive). Hence, this factor construct supports the validity of the CoI’s conceptual framework of Social (Affective, Interactive and Cohesive), Cognitive and Teaching Presence. An item analysis was conducted to test the reliability of each factor as well as the CoI instrument. All four elements had high reliabilities with Cronbach’s Alpha (α) of .89, .94, .81, and .78 respectively. Reliability of the CoI survey instrument was .945.

Figure 4.10 Scree Plot for CoI Survey
4.2.2 Procedural Domain Survey

A secondary EFA was conducted, using the results from the 34 CoI survey items and the 12 Procedural Domain (PD) survey items with direct oblimin rotation and no limitation on the number of factors to extract, to identify the factors in this data set. The EFA yielded ten factors with eigenvalues > 1. However, based on the noticeable decrease in magnitude after the initial three factor's eigenvalues, the respective scree plot shown in Figure 4.11, fails to inform the possibility of factors greater than three. This factor structure accounts for 51.43% of the total variance in respondent scores. Each of these factors and their percentages of variance are 36.68% (Supporting Discourse), 8.30% (Teaching Presence), and 6.45% (Social and Cognitive Presence). An item analysis was conducted to test the reliability of each factor as well as the CoI and PD survey. All factors had high reliabilities with Cronbach’s Alpha (α) of .93, .94, and .90 respectively. The reliability of the CoI and PD instrument was .960. The eigenvalues, percentage of variance and reliability (Cronbach's Alpha) of these factors for the EFA using the 46 CoI and PD survey items is shown in Appendix 10.

![Scree Plot](image)

**Figure 4.11 Scree Plot for CoI & PD Survey**
4.2.2.1 Structural Equation Modelling

The next stage of analysis was to explore both the 34 CoI item model and the 46 CoI and PD item factor model with sufficiently high internal reliability in each factor. These models were evaluated by the means of structural equation modelling (SEM) with the use of AMOS version 22.0. Prior to analysis, the univariate normality of each continuous variable was assessed in SPSS 22.0. Although the variable Teaching Presence had a kurtosis value > 1.00, this was within an acceptable range (−3 to +3) and was not expected to affect the results of SEM. The multivariate normality was assessed using statistical methods in AMOS 22.0 and was verified to be satisfactory. Based on the 4 and 3 factor CoI and PD structures revealed as result of the EFA, a number of possible factor models were initially tested and analysed through SEM. These structures were examined both with and without latent variables correlating. Subsequently, a number of iterations were examined with rotations made based on resulting Cronbach’s Alpha values for each factor based on the removal of test items. Considering the similar demographic of the respondents, gender, age or year of study would not have a significant impact on the results and therefore, were not included. The fit indices of examined factor models using SEM are represented in Table 4.10.

<table>
<thead>
<tr>
<th>Model</th>
<th>χ²</th>
<th>DF</th>
<th>CFI</th>
<th>TLI</th>
<th>RMSEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Factor EFA Model (CoI)</td>
<td>953.513</td>
<td>521</td>
<td>0.733</td>
<td>0.712</td>
<td>0.105</td>
</tr>
<tr>
<td>CoI Correlated</td>
<td>986.695</td>
<td>524</td>
<td>0.714</td>
<td>0.694</td>
<td>0.108</td>
</tr>
<tr>
<td>3 Factor EFA Model (Q_01 – 02)</td>
<td>1760.303</td>
<td>899</td>
<td>0.648</td>
<td>0.630</td>
<td>0.112</td>
</tr>
<tr>
<td>3 Factor EFA Model (CoI &amp; PD)</td>
<td>1854.690</td>
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<td>0.642</td>
<td>0.623</td>
<td>0.113</td>
</tr>
<tr>
<td>CoI &amp; PD Correlated</td>
<td>1950.486</td>
<td>983</td>
<td>0.630</td>
<td>0.610</td>
<td>0.114</td>
</tr>
<tr>
<td>CoI &amp; PD Correlated (S &amp; C)</td>
<td>1977.627</td>
<td>986</td>
<td>0.621</td>
<td>0.602</td>
<td>0.115</td>
</tr>
</tbody>
</table>

The fit indices shown in Table 4.10 reveal that none of the factor models examined achieved the required acceptance values (e.g. CFI > .90; TLI > .90; RMSEA < .08). However, consistent with the CoI framework, SEM did confirm the hypothesised relationships among the 3 presences and 34 CoI items (Appendix 13). Perceptions of teaching presence indicated a significant effect on perceptions of cognitive presence and perceptions of teaching presence were notably associated with social presence. The mediating effects of social presence on cognitive presence were also confirmed. Although the 3 factor CoI model was proven to be a relatively good fit in terms of
the six models examined through SEM. Based on the 34 item CoI survey, the results indicate that the 4 factor EFA model with correlating latent variables (Figure 4.12) revealed the most acceptable fit indices (i.e. CFI, TLI, RMSEA) of all models tested. These indices suggest a low–moderate fitting model consistent with the sample size. Using the 46 CoI and PD items, four possible models were examined through SEM. Although the four models revealed poorer fit indices than previously tested models, the 3 factor EFA model with correlating latent variables (Appendix 13) was best fit.

Figure 4.12 Relationship of 4 Factor EFA Model (CoI)
4.2.3 Usability and Feasibility Survey

The System Usability Scale (SUS) was used to investigate teachers’ response to the usability of the technological (Edmodo) and pedagogical approaches (EPI Model). The 10 item, Likert scale instrument which included open sections for teachers to provide additional comments in relation to each question and concluding statements was delivered at the end of the research intervention before discussions took place.

Table 4.11 shows the teachers’ response to the usability of the ICT-based approach. As Table 4.11 shows, the highest usability score the ICT approach received was 100 and the lowest was 67.5, with an average of 82.86 and a standard deviation of 11.31.

Table 4.11 ICT Usability Scores

<table>
<thead>
<tr>
<th>ICT Usability Questions</th>
<th>Q_01</th>
<th>Q_02</th>
<th>Q_03</th>
<th>Q_04</th>
<th>Q_05</th>
<th>Q_06</th>
<th>Q_07</th>
<th>Q_08</th>
<th>Q_09</th>
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<th>Score</th>
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Table 4.12 shows the teachers’ response to the usability of the EPI-based approach. As Table 4.12 shows the highest usability score the EPI approach received was 72.5 and the lowest was 42.5, with an average of 51.79 and a standard deviation of 13.52.

Table 4.12 EPI Usability Scores

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4.3 Critique of the Integrated Approach

Framed by the focus of the research, qualitative data was collected by means of both teacher interviews (pre- and post-study) and pupil focus groups (post-study) in each school to explore teachers and pupils response to supporting discourse using TMC, and analysed using a computer aided qualitative data analysis system (CAQDAS).

Following the delivery of the preliminary intervention lesson and having registered pupils on Edmodo, semi-structured interviews were conducted to explore teachers’ technological and pedagogical approaches to integrating the educational transaction. Subsequent to the completion of the educational transaction, semi-structured focus groups were conducted to evaluate the pupils’ response to the research intervention. A post-study interview was conducted with teachers in an effort to authenticate what happened and substantiate the pupils’ response to see what the perceived effect was. This follow-up interview involved the retrospective reporting of the research study.

A summary of the main findings from the teacher interviews and pupil focus groups is presented below and will be developed on in more detail in the following sections:

- The impediments to supporting discourse using TMC were fully controlled
- The response to supporting discourse using TMC were positively disposed

However, the findings will be discussed in terms of emerging themes and categories, refer to Appendix 14 for a comprehensive representation of the qualitative findings.

4.3.1 Design and Implementation

The purpose of the preliminary interviews was to consolidate teachers understanding of ‘what is going to happen’. Questions were designed to explore the steps taken to support the integration of TMC into classroom practice and to benchmark the initial perceptions, challenges and the recommendations associated with integrating TMC. The post-study interview was conducted in an effort to determine ‘what did happen’.

The complete coding matrix for the teacher interviews is presented in Appendix 10.

The findings present three core themes as developing during the cycles of analysis, these include ICT policy in schools, ICT access in schools and ICT usage in schools.
Describing the technological approach developed to support the integration of TMC, 5 of the 7 teachers interviewed acknowledged the schools ICT policy, with specific reference to the use of mobile phones on school grounds, as being a key contributor. Hence, schools ICT policy influenced both the choice of room in which the research intervention was carried out and the facilities for supporting discourse using TMC. This gave rise to ICT access in schools being identified as the second theme which influenced teachers’ development of technological approaches to support discourse. Within this, teachers discussed the pupils’ access to ICT both in school and at home. As a theme, ICT access in schools consisted of the classroom in which the research intervention was integrated into (i.e. technology room, computer room), the amount of class time allocated to the intervention (i.e. whole class, partial class, extra class), and the pupils capacity to participate in the intervention (i.e. restricted, unrestricted). Though, this was an initial concern, access to ICT did not impact the research study. Therefore, with a particular focus on the desktop and mobile applications, ICT usage in schools was the final theme identified as contributing to the integration of TMC.

Additionally, it was critical to also understand the pedagogical approaches developed by teachers in order to support the integration of TMC into their classroom practice. The findings present four themes as developing through the cycles of analysis, these are selecting content, setting climate, supporting discourse and establishing presence, with each theme having various sub-codes which contribute to the emergent themes. For example, when describing the pedagogical approaches developed to support the integration of TMC, teachers recognised the importance of selecting content, while referencing the activities of teaching, outcomes of learning, and tasks of assessment. Though selecting content was considered to be important to all teachers interviewed, the most sourced theme identified as contributing to the pedagogical approaches they implemented in an effort to facilitate the integration of TMC was setting the climate. Within this, teachers discussed how the design of the learning environment and the delivery of the educational transaction were influencing factors in setting the climate. Subsequently, to help set the appropriate climate for teaching and learning, and with a particular focus on the use of posts, comments, and hashtags, supporting discourse was the next theme to be identified as contributing to teachers’ integration of TMC. The final theme identified was establishing presence, as monitoring online behaviour was considered to be very important by teachers in supporting discourse using TMC.
4.3.2 Beliefs, Attitudes and Values

In response to discourse in their everyday learning being supported by ICT, pupils discussed three core themes which consisted of interest, motivation and engagement. When asked if the discourse supported by ICT was different from the discourse in the classroom, pupils acknowledged the variation in roles, support and interaction. Further, when asked if discourse supported by ICT is appropriate for design-based activity, in answering this question they discuss content, outcomes and development. However, for the purpose of this section of the findings, the focus is on the fourth and fifth categories found, i.e., pupils’ ability to evidence and communicate learning. The cycles of analysis revealed three themes relating to ideas, process and solutions. Pupils indicated how the spatial and temporal independencies provided by the ICT extended time for critical thinking and reflection and to give individualised feedback, which then resulted in the development of more robust thoughts, ideas and feelings. This led pupils to think about the influence discourse had on the process of learning. Pupils indicated how the process of working iteratively, adding posts and comments, collaborating with others and subsequently uploading data files to evidence learning, changed their understanding of learning, viewing it as a social and cognitive process. With a specific focus on the amount of work demonstrated, the final theme identified was the influence that discourse had on the solutions offered as evidence of learning.

In addition to understanding the influence discourse supported by ICT had on pupils learning and the evidence of their learning, it was important to understand the pupil’s ability to engage in discourse supported by ICT. The findings presented three core themes as developing during the cycles of analysis, these included the pupils’ ability to post, comment, and hashtag posts and comments. Each theme was significantly referenced and distinctly acknowledged in all focus-groups. It was found that in all schools pupils were confident in their ability to both post and comment, as were teachers, however, they were more hesitant in their use of hashtags. Pupils indicated how the language used to describe the hashtags was difficult because it was new. However, pupils did indicate that with time, they became familiar with the hashtags. In addition, pupils identified the potential of hashtags and their influence on learning. Hence, the perception of both teachers and pupils is that with practice and experience hashtags can be a powerful and useful medium for supporting discourse using TMC.
4.4 Summary

A summary of the main findings of this research study have been categorised into the four sections presented below, and will form the basis of the subsequent discussion. These findings will be discussed in relation to the key contributions of this research which are ‘Generating a Common Language’, and ‘Creating the Space for Learning’.

The use of Learning Protocols Created a Shared Language of Understanding
- The nature of the relationship between the frequency of teachers and pupils use of protocols is evidence of an iterative and interactive process of learning
- The hierarchical structure in the frequency of protocols shows that learning protocols enabled pupils to evidence their thinking in terms of progression
- The alignment between the pupils and researchers use of learning protocols indicates pupils understanding of the use of learning protocols did increase

The use of Learning Protocols Supported Cognitive & Meta-Cognitive Process
- The process of tagging a post or comment with learning protocols encourages pupils to critically think and reflect on learning and the evidence of learning
- The correlation between learning protocols and cognitive presence shows the nature of supporting discourse and the language of the discourse is cognitive

Supporting Discourse using TMC had a Positive Effect on Teaching & Learning
- The design and implementation of the EPI Model stimulated both the pupils, and teachers, interest, motivation and engagement in the process of learning
- The integration of the EPI Model allows ICT be fully realised and exploited for the purpose of making real contributions to both teaching and learning

The Perception of Discourse Enhances the Conditions for Teaching & Learning
- The nature of the relationship between the EPI Model and the CoI Model shows it was an independent factor that can support the constituent processes
- The process of learning was perceived by pupils as being social and cognitive as result of supporting discourse using technology-mediated communication
- The affective interactions which include the use of emotions, humour and self-disclosure was self-regulated by the pupils in the learning environment
5 Discussion
5.1 Generating a Common Language

From the outset this study recognised that if we are to consider using the CoI model as a framework for ICT-supported learning within second level education, teaching presence would have a significant influence on the teaching and learning experience. However, the capacity to identify current and targeted progressions was fundamental as to when a teacher should or shouldn’t intervene in the process of pupils learning. However, to do so properly can be difficult even for the most experienced teacher. For this to work both in theory and practice, learning protocols based on a common language of progression had to be initially established in order to support discourse.

5.1.1 A Shared Language of Understanding

As teaching presence is the design, facilitation and direction of social and cognitive processes for realising personally meaningful and educationally worthwhile learning outcomes, this research argued that discourse must ensue around both learning processes and outcomes to inform the quality of learning and efficacy of teaching. This study implemented the use of learning protocols (i.e. hashtags) to translate the EPI Model into a pedagogical and technological approach to help teachers and pupils articulate a common language of progression around the intended learning processes. Accordingly, this research shows that by creating a shared language of understanding the relationship between the frequency of teachers and pupils’ use of these protocols, as shown in Figure 4.2, is evidence of an iterative and interactive process of learning. As is presented in the following extract taken from T_01, this was possible because the use of protocols allowed the reader to see and understand the process of learning, and in turn informed a person’s capacity to identify current and targeted progressions and whether or not they should or shouldn’t intervene within the process of learning:

... when I can see what they hashtag, I can see what the pupils are thinking, so if its #conceptualise maybe they are looking to show what their ideas are, it gives teachers and whoever else is looking at it an idea of what the pupil or the other person’s actually thinking and how they're actually doing it, (T_01).

In comparing the frequency of protocols assigned by participants and the researcher, a clear sense of hierarchical progression in the protocols was shown in Figure 4.3, which further enabled participants to evidence their thinking in terms of progression.
However, the classification of this hierarchy reveals similar issues which concern the CoI, i.e., learners are not reaching higher phases of critical thinking and reflection (Garrison et al. 2000; Garrison & Arbaugh 2007; Garrison & Cleveland-Innes 2005; Garrison & Vaughan 2008). Those studies claimed that the apparent inability to move to the higher phases was very likely associated with teaching presence. However, the results of the transcript analysis show that in schools where teachers recorded high percentages of supporting discourse, pupils showed a greater capacity to move beyond exploration into the integration and resolution of cognitive presence. These findings are particularly important as they show that effective use of the learning protocols along with engaged teachers and supported discussions have been found to be the most consistent predictors of the development of cognitive presence. In support of this, the results from 3 Factor SEM CoI and PD model (Appendix 13) showed that the 12 EPI survey items were clearly identified as being a distinct factor. Hence, the findings indicate that the EPI Model can be used in conjunction with the CoI to support the design, facilitation and direction of social and cognitive processes. Although teachers and pupils reported that having to assign the protocols developed as part of the EPI Model was difficult at first due to the complexity of the language, results of the pupil and teacher interviews suggest that with practice and experience participants’ use of learning protocols can build a common language of progression:

... some of them were confusing, we would probably need a few more weeks to get used to them more [...] but I think we would get used to them, (P_48).

Subsequently, although the EPI Model received average usability scores (Table 4.12) in comparing the agreement of protocols assigned by pupils and the researcher, Figure 4.4 revealed that pupils understanding of this ‘meta-language’ of progression increased and began to align with the researches understanding of learning protocols. The alignment between the pupils and researchers use of learning protocols begins to offer some validation of the usefulness of the EPI Model for supporting discourse. Furthermore, the following extract presented below taken from P_17 (focus group), shows pupils could talk about protocols using the language given by the descriptors:

... I understood them in the end, if someone wanted you to examine what is right or what is wrong in their post, they would use hashtag analyse, (P_17).

This is significant because giving pupils a language they can use, gives them a voice.
5.1.1.1 Giving a Voice to All Learners

The integration of the EPI Model for supporting discourse in second level education not only generated a common language for a shared understanding of progression, it provided a medium for pupils to have their voices heard in the process of learning. The results of a three year study (Nystrand 1997), that focused on 2400 pupils in 60 different classrooms indicated that the typical classroom teacher spends under three minutes an hour allowing pupils to talk about ideas with one another and the teacher, and is dependent upon teacher-centred questions which had predetermined answers. It became increasingly clear from the results of the interviews and focus groups, that both teachers and pupils acknowledged that in a standard lesson period, there simply isn’t enough time for pupils to discuss their ideas with one another and the teacher. However, as a result of the spatial and temporal independencies provided by the ICT this study has indicated that pupils had more time to both ask and answer questions on the issues they found to be personally meaningful and educationally worthwhile, which ultimately led pupils in the development of more robust ideas and solutions. In fact, the percentage of codes assigned by category reveals pupils spent more time communicating the evidence of their learning than any other activities (Figure 4.6).

In addition to not participating within much discourse with others in the classroom, pupils also discussed the worrying anxieties and performance issues they usually experience when being asked a question in front of others in a traditional classroom. However, because the focus of the learning protocols, and therefore the EPI Model, was on the process of learning and not on the “right answer”, pupils felt that it was more encouraging to present and discuss their ideas as there was no “wrong answer”. For example, this is shown in the following extract taken from P_32 (focus group):

... if you're told to stand up in class to give out like, what your idea is you'd be a bit nervous but online like, you're not really as worried. [...] It's easier really like, you weren't worried, you could think about what idea you wanted to post up and like, even if it was a bad idea you post up like, in class maybe you wouldn't get good feedback but like online everyone gave good feedback to you and if there was something wrong they could help you with it, (P_32).

The results of the pupil surveys and findings of the focus groups both indicate that pupils felt comfortable interacting online because it was a familiar approach to TMC.
5.1.1.1 Reaching the Middle Ground

By providing a medium for pupils to have their voices heard in the learning process, teachers' perceptions of who they initially thought would have most used the model were changed as teachers started to hear from the pupils who wanted it the most. This view is further explained in the following extract taken from T_01 (post-study):

... what I've found really interesting was, kind of the middle ground pupils, they're in here to learn but at the same time have they're bit of fun as well, they were the ones that were very quick to sign up to it. I think a lot would be to do with them wanting to learn but not wanting to look like the swots. [...] Because like even when they initially signed up two of the boys I would class in that group, they were the ones that were uploading and thinking about the work but they still wanted to try and fit in and I think this is a great place for them in the sense that when they go home they don't have to look the part. Pupils can be at home and relax a bit and they can think about their ideas, they can do a lot of hard work at home and upload it there for people to see and they don't have somebody in the classroom mocking them, it's monitored online so pupils can't mock them or post bullying comments to them, (T_01).

While taking advantage of a more comfortable learning space to avoid being teased is a possible explanation for the pupils in the ‘middle ground’, i.e., pupils considered not to be in the higher or lower ends of the class, to feel supported by the approach. The following extract from T_07 (post-study) offers another possible reason for this:

... I think the main reason behind that is when you have a pupil that’s in the higher end of the class, they tend to get their work done quicker in class and then they get time to ask you a question. While somebody else they may work hard but they just might not be as quick at understanding or visualising what we are doing and it takes them a little bit longer to do the question in class. As it is only a single class, sometimes they wouldn't get the question finished, when those pupils go home and they hit a problem, they can post it online. While your A pupil would have the question mostly finished in class, they would get to ask the question, they would have hit that problem in class, they would ask that question before they would leave class. Whereas some of the other pupils wouldn't, and when they would go home and they would have that problem, which is fine because that's what the ICT is there for, (T_07).

Hence, due to the integration of the EPI Model for supporting discourse using TMC the pupils who often go unnoticed within the classroom were becoming more visible. This allows those pupils to make the evidence of their learning more visible which supports teachers in planning their intervention strategies and decisions on evidence.
5.1.2 A Meta-Cognitive Process of Learning

In addition to generating a common language of understanding between participants, the nature of discourse and the language of that discourse was shown to be cognitive. In light of the perceived relation between learning protocols and cognitive presence, that emerged from the coding by the researcher in the transcript analysis (Table 4.4), this research was led to consider the display trend of the codes assigned per school. Accordingly, the findings indicated that learning protocols and cognitive presence followed a near identical path in all of the schools during the activity (Appendix 12). Subsequently, a correlational analysis was conducted between the codes assigned by the researcher to learning protocols and to social, cognitive and teaching presence. The results of this analysis (presented in Table 4.5), clearly indicated that there was a significant positive correlation between learning protocols and cognitive presence, and showed that supporting discourse and the language of that discourse is cognitive. For example, interactions coded within the resolution category of cognitive presence were also frequently coded as in the cogitation category of the experiential domain. Therefore, this research indicates that, in conjunction with the proposed EPI Model, the use of learning protocols is a relevant approach to supporting cognitive presence.

This research not only shows that the language of supporting discourse is cognitive, but it further indicates that the process of supporting discourse is meta-cognitive. Although the spatial and temporal independencies provided by the integration of ICT gave pupils more time to critically think and reflect on their interactions with others, by working iteratively, using the EPI Model to assign learning protocols to posts and comments, working with others, and uploading subsequent data files as evidence, encouraged pupils to critically think and reflect on their interactions with themselves. For example, as presented in the following extract as taken from P_77 (focus-group), the pupils identified two common factors that promoted meta-cognitive awareness:

... with the hashtags, we were analysing our own work and we were sharing it with everyone else, we were communicating our ideas with everyone else, but we were also communicating with ourselves, it's awareness for ourselves as well at the same time, it was like killing two birds with one stone (P_77).

This included having to share the evidence of your learning within the public sphere and having to assign a learning protocol that was appropriate to the evidence shared.
5.2. Creating the Space for Learning

As previously discussed in the literature, traditional practice allows for education and instruction to be delivered in a physical classroom setting and the current practices of online and blended learning allows for education and instruction to be delivered primarily via the internet in a virtual classroom setting, or delivered in part via the internet in a virtual classroom setting and in part in a physical classroom setting. However, with the latest advancements in ICT and cloud-based software, education and instruction are no longer confined to a ‘classroom’ setting as new configurations for the delivery of education and instruction are possible in any conceivable setting. This enables the development of a new space or dimension for teaching and learning where borders are only limited by the imagination of those who participate in them, blurring the traditional institutional, spatial and temporal boundaries of schooling.

5.2.1 The Effect on Teaching and Learning

Considering the frequency of posts and comments recorded during this intervention, this research shows that teachers and pupils responded positively to the integration of new technological and pedagogical approaches within the traditional environment as well as the ability to extend the teaching and learning beyond the classroom setting. Teachers and pupils welcomed this contemporary approach indicating this stimulated their interest, motivation and engagement in the regular day-to-day school activity. For example, as was presented in the following extracts taken from T_02 and P_22:

... I really enjoyed it, I found it very interesting. I think it's great for pupils and for teachers as it's hard to give everyone the feedback they need in class, but when it's online you can give everyone a bit more feedback than usually, and you can identify the pupils that need your help a lot more easily, (T_02).

... it was like Facebook for school, you could interact and you could get feedback off your friends and then you have to change your design and challenge yourself to see how you could improve it and what you could take away or what you could add to it that would make it a better design, (P_22).

What is most significant in these extracts is the language used, as it clearly indicates that what teachers and pupils valued the most were the opportunities for discourse. However, this didn’t occur because systems of ICT made it technologically possible, rather this was as a result of the integrated pedagogical approach of the EPI Model.
In addition, since technology is linked to better pupil performance in contexts where ICT extends teaching and learning and enhances classroom practice (OECD 2015), and seeing as the most used learning protocols assigned by teachers and pupils were LP10 (Revise): looking over an idea or feeling in part or in full to correct or better it, and LP04 (Analyse): examining an idea or feeling in order to explain and interpret it. This research shows that supporting discourse using TMC helps to extend learning and enhance practice as it promotes greater periods of critical thinking and reflection and hence, attends to the integration of ICT and the effective pedagogical use of ICT. Furthermore, as was presented in the following extract taken from P_78 and T_05, pupils indicated that learning protocols made the process of learning more effective:

... it was really good for learning because you can search for the hashtag, to see all the posts with that hashtag and find what you were looking for (P_78).

... they were thinking more, because they were allowed more time. If you're given more time to answer a question you're going to answer it better (T_05).

Subsequently, the following extract presented below taken from T_06 (post-study), indicates how the asynchronous nature of the approach enhances classroom practice:

... I can have the homework checked before coming into school, being able to contact them at home and solve the problem at home, you're able to move on, and you’re constantly going forward with new material in every class (T_06).

For these reasons, the integration of the EPI Model allows ICT be fully realised and exploited for the purpose of making real contributions to both teaching and learning, and can ensure our schools don’t lag considerably behind the promise of technology. Although teachers and pupils welcomed the use of ICT in their classroom activity it was recognised that it functioned as the medium for the activity only, to support the richness, involvedness and connectedness of the pedagogical approach and provide the right support and the right feedback, in the right time and place, at the right level. This was the priority concern of the research intervention from the outset, to ensure that any form of technology introduced within the classroom activity should operate as an enhancement for the activity only, rather than as a distraction or as a distortion. The integration of ICT did not act as a barrier for supporting discourse in this study, as teachers were seen to fully control the impediments associated with using TMC.
5.2.2 The Conditions for Teaching and Learning

As discussed earlier, a common pitfall in ICT-supported learning is restricting social interaction to educational transactions aimed exclusively at cognitive processes while interventions aimed at social-emotional processes are ignored or neglected. This is due to concerns that affective interaction will undermine the learning process. The results from the transcript analysis and frequency of codes assigned by element indicated the nature of the participants’ interaction was approximately 30% social. The findings indicate that participant activity occurred mostly in the interactive and cohesive categories of social presence which included complimenting others or the contents of others’ messages, building and sustaining a sense of group commitment. The affective category which includes use of emotions, humour, and self-disclosure was the least frequently coded category of social presence during the intervention. However, as presented in the following transcript excerpt from S_05, when affective interactions occurred they were controlled by the community of learners themselves.

P_61  No I hate knowing what I did wrong.
P_60  You are not actually comparing the clocks Max, #formalise.
P_56  This is showing a new and an old clock NOT comparing, #formalise.
P_61  #LetMeBreath.
P_56  #NO!! 😂😂
P_60  I would recommend that ye stop arguing guys, #formalise.

Consistent with the CoI framework the results of SEM did confirm the hypothesised relationships among the 3 presences and 34 CoI items (Appendix 13). Perceptions of teaching presence indicated a significant effect on perceptions of cognitive presence and perceptions of teaching presence were notably associated with social presence. The mediating effects of social presence on cognitive presence were also confirmed. However, it was shown that a four, rather than a three factor model was of best fit. This model identified the affective category of social presence as a separate factor, which suggests that because of the physical environment of second level education, as opposed to the virtual settings of online education, “getting to know other pupils” and “forming clear impressions of other pupils”, presented itself as a distinct factor. Therefore, and in conjunction with the example presented above, this indicates that the use of learning protocols shifted the responsibility from the teacher to the pupils to ensure interactions remained personally meaningful and educationally worthwhile.
5.2.2.1 Shifting the Responsibility

Considering pupils were now becoming more aware of their own learning, teachers' perception of pupils’ capacity to assume greater control over their learning changed. This shift places a greater emphasis on pupils learning, on the quality of that learning and on the respective roles of teachers and pupils involved in that learning process. The significance of this change, as presented in the extract below taken from P_47, shows that it leads to a more positive and effective teaching and learning experience:

... if your teacher, if there’s sort of a distance between you and your teacher, if your teacher is always really kind of stern or strict or always telling you to shut up, you're not really going to want to work for them and a lot of the time if a teacher, if you get the message that a teacher thinks they're better than you then you’re not going to feel very connected to them, you’re not going to feel really, you're not going to want to do things for them but whereas when a teacher is really kind of social and really on your level in that way, when they kind of understand what you’re on about, it really makes things easier. So in that sense the ICT really helped there as well because the teacher got the chance to kind of post on there as well, like he, he was one of us, (P_47).

In addition to being more connected, the following extracts taken from P_80 (S_07) and P_77 (S_07), reveals that pupils also felt as if there was a shared level of respect:

... it’s just more grown up like, it’s not like we’re children anymore like, you’re like grown up enough to be in a group and with your teacher, (P_80).

... ya and they are like taking time out of their own lives to post stuff and answer things, they’re not helping themselves like, they’re helping us, (P_77).

As is presented in the following extract taken from T_07 (post-study), it wasn’t only pupils who recognised this shift in roles, the change was also welcomed by teachers:

It improved the relationship of the class and I think they appreciated that and one thing I noticed was there was a lot more respect from pupils when they saw that I was giving up my time to post online and they were giving theirs you could see that everybody was putting more into the subject. There was a lot more appreciation from everyone, myself and the pupils included, (T_07).

This change in roles supports teachers and pupils individual and collaborative work and informs their capacity to identify pupils’ current and targeted progressions which is fundamental to when they should or shouldn’t intervene in the process of learning.
5.2.2.1 Identifying Targeted Progressions

As discussed so far the impact of the EPI Model for supporting discourse using TMC created a new space where education and instruction can be delivered traditionally and via the internet through embedding virtual presence into the physical classroom. Translating the EPI Model to facilitate the pedagogical and technological approach by using protocols generated a shared understanding of progression around learning and supported teachers and pupils in both their individual and collaborative work. Finally, the use of these protocols provided opportunities for pupils to evidence their learning and to make their learning more visible which supported teachers and pupils alike in planning their intervention strategies and basing their decisions on evidence. Accordingly, teachers were able to use this evidence in their planning for learning and to provide individual, developmental and personalised learning for each pupil. As discussed in the extract below taken from T_01 (post-study) and was presented in the findings, the visibility and authenticity of learning provided by the EPI Model in conjunction with the asynchronous capacity of TMC has evolved teachers pedagogy into a more diagnostic and formative approach to planning for teaching and learning:

... it made my life ten times easier because I could, like we talk so much about planning and it just make my planning so much easier because instead of trying to come into class with the assumption of what they knew, I could come into class knowing what they knew and knowing where I needed to develop and where I needed to go. [...] When I was heading into my 5th year class I knew what they knew, I could come in with resources that benefited what I was going to do in class and 9 times out of 10, what I thought they knew or what the posts showed me they knew, they did know, and it showed me what they didn’t know, (T_01).

Although the integration of the EPI Model into classroom practice resulted in pupils assuming greater responsibility for their learning and given that affective interactions were controlled by the community of learners so as not to undermine the learning, teaching presence and instructional practice was still required throughout the study. Approximately half of all teaching interventions focused on giving direct instruction, such as presenting content, questions and focusing the discussions on specific issues. The results further shows that direct instruction was present and frequently recorded throughout each week of the research intervention in all of the participating schools. Hence, teachers used the EPI Model to identify current and targeted progressions which was fundamental to when they decided to intervene in the process of learning.
6 Conclusion
6.1 Closing Reflections

In the context of supporting discourse using technology-mediated communication, the aim of this research was to conduct an exploratory study which investigates the development of a conceptual model for enhancing practice in second level education. Accordingly, the following conclusions have been drawn as a result of this research:

1. This study indicates encouraging results for supporting discourse using TMC. As shown, teachers and pupils responded positively to the integration of new pedagogical and technological approaches into their traditional environments as well as the capacity to extend teaching and learning beyond the classroom. Pupils embraced this contemporary approach, indicating this stimulated their interest, motivation and engagement in the regular day-to-day school activity.

2. The development of the EPI Model for supporting discourse using TMC created a shared understanding among teachers and pupils about progression. This capacity to identify current and targeted progressions was fundamental as to when the teachers decided to intervene in the process of pupils learning. This supported teachers and pupils in both individual and collaborative work and in planning their intervention strategies and decisions based on evidence.

3. The integration of EPI Model in the pedagogical and technological approach using learning protocols (i.e. hashtags) facilitated the metacognitive interplay between teachers and pupils within the context of socially-mediated activity. By tagging a post or comment with a learning protocol in the public sphere teachers and pupils analysed the meaning or intended process of that message which ultimately led to their development of more robust ideas and solutions.

4. The effectiveness of the EPI Model for supporting discourse using TMC documented the complex, real world of teaching and learning by providing a novel approach to inform the process and evidence of teaching and learning. This is a formative method of valuing a pupils’ voice in evaluating the design of the learning environment, and the delivery of the educational transaction.
7 Future Work
7.1 Recommendations

Areas of future work stemming from the conclusions of this study are now outlined.

Although the EPI Model was shown to have a significant influence on supporting discourse using TMC on both the process and evidence of teaching and learning, since the context of this study was exploratory, future work should be confirmatory and endeavour to validate the EPI Model, learning protocols and survey instrument.

While the alignment between the pupils and researchers use of learning protocols indicated that pupils understanding of the use of learning protocols did increase, more work is needed to increase usability, feasibility and stability of the EPI Model. This will incorporate the evaluation of a more accessible language used in the model.

This study highlighted the positive influence of supporting discourse using TMC on the nature of teaching and learning within the context of design-based education. Future work is needed to investigate if the EPI Model can be successfully integrated into alternative contexts both within second level education and in higher education.

In an effort to reduce variability among the integration of the technological approach pre-service teachers had been chosen to participate in this research due to their first-hand experiences with ICT and the use of the EPI Model in learning and assessment. Further work is required to examine the use of the EPI Model by in-service teachers.

For the purpose of this study, 7 schools, in partnership with the school principals, co-operating teachers, pre-service teachers and their pupils volunteered to integrate the proposed research intervention to enhance practice in their single-site classrooms. Additional work should investigate the potential of connecting multi-site classrooms.

Finally, the results of this study revealed a four, rather than a three factor CoI model, classifying the affective category of social presence as a separate and distinct factor. Future research is necessary to validate this CoI model in second level education. This will require the deployment of the CoI survey using a much larger sample-size.
8 Publications
8.1 Book Chapters


8.2 Journal Publications


8.3 Conference Publications


8.4 Conference Presentations


9 References
9.1 References


Balasubramanian, K., Jaykumar, V., & Fukey, L. N. (2014) ‘A study on student preference towards the use of Edmodo as a learning platform to create responsible learning environment’, *Procedia-Social and Behavioral Sciences, 144*(1), 416-422.


2011, Nashville, Tennessee, 7-11 Mar, Chesapeake: Association for the Advancement of Computing in Education.


Murphy, E., & Ciszewska-Carr, J. (2005) ‘Sources of difference in reliability: Identifying sources of difference in reliability in content analysis of online asynchronous discussions’, International Review of Research in Open and Distance Learning, 6(2), 1-12.


10 Appendices
Appendix 1
A 1.1 Confirmation of Ethical Approval

14th October 2015

Dr. Niall Seery
Department of Design and Manufacturing Technology
University of Limerick

RE: 2016_10_01_S&E Supporting Technology-Mediated Discourse in Second Level Education
Investigator(s): Niall Seery, Donal Carty, Adrian O’Connor

Dear Niall,

The Faculty of Science and Engineering Research Ethics Committee has granted full approval to the above application.

Yours sincerely

[Signature]

Dr Thomas Waldmann
Chair
Science & Engineering Research Ethics Committee

cc. Donal Carty, Adrian O’Connor
A 2.1 Standardisation of Design Briefs

Design of the Educational Transaction (S_01)

A school gymnasium for physical education programmes within second level education allows students to develop healthy habits that are beneficial throughout life. Students who participate in a gym or physical education class have shown increased learning and are more alert in the classroom.

A. Carry out a design investigation on the physical form and features of a school gymnasium. Your design investigation should include a brief exploration of physical activity over time.

B. Show graphically how you would physically modify the chosen gymnasium to improve its overall accessibility. Include an analysis of its shape, ergonomics, features, materials, etc.

or

Design and graphically communicate a new concept design for a school gymnasium based on a selected functional capacity or advancement and aimed at a particular target market.

Design of the Educational Transaction (S_02)

Accessibility is the degree to which a product, device, or environment is available to as many people as possible. It can be viewed as “ability to access” and benefit from something. Accessible housing, therefore, is housing which is comfortably usable by all people, including disabled people.

C. Carry out a design investigation on the physical form and features of accessible housing. Your design investigation should include a brief exploration of accessibility over the ages.

D. Show graphically how you would physically modify the chosen dwelling to improve its overall accessibility. Include an analysis of its shape, ergonomics, features, materials, etc.

or

Design and graphically communicate a new concept design for accessible housing based on a selected functional capacity or advancement and aimed at a particular target market.

Design of the Educational Transaction (S_03)

A roof is part of a buildings envelope which covers the uppermost part of a dwelling or shelter and gives protection from animals and weather, notably rain or snow, but also heat, wind and sunlight. A roof is dependent upon the purpose of the building that it covers, and available roofing materials.

A. Carry out a design investigation on the physical form or features of the structure of a roof. Your design investigation should include a brief exploration of roof structures over time.

B. Show graphically how you would physically modify the chosen gymnasium to improve its overall accessibility. Include an analysis of its shape, ergonomics, features, materials, etc.

or

Design and graphically communicate a new concept design for accessible housing based on a selected functional capacity or advancement and aimed at a particular target market.
Design of the Educational Transaction (S_04)

Practically every household and workplace has at least one wall clock. Since the invention of the clock in the mid 1600’s, these artefacts have become more compact and are now manufactured from a wide range of materials. Many existing designs are novel in terms of their shape and form.

A. Carry out a design investigation on the physical form or features of existing wall clocks. Your investigation should begin with a brief exploration of existing wall clocks over time.

and

B. Show graphically how you would physically modify the design of an existing wall clock to improve its usage. Include an analysis of its shape, ergonomics, features, materials, etc.

or

Design and graphically communicate a new concept design for a wall clock which is based on a selected functional capacity or advancement and aimed at a particular target market.

Design of the Educational Transaction (S_05)

Assistive Technology is defined as a piece or item of equipment which is used to help an individual perform some task within their daily life. These devices are often mechanical aids, which substitute or enhance the functional capacity of some physical, visual or mental ability that has been impaired.

A. Carry out a personal design investigation on an existing form of assistive technology. Your design investigation should include a brief exploration of such technology over time.

and

B. Show graphically how you would physically modify the design of the chosen technology to improve its usage. Include an analysis of its shape, ergonomics, features, materials, etc.

or

Design and graphically communicate a new method of assistive technology which is based on a selected functional capacity or advancement and aimed at a particular target market.

Design of the Educational Transaction (S_06)

Lecterns are available in a wide range of shapes, forms and materials. Originally they consisted of a sloping surface with a ledge to hold books or papers while its user read from a standing position. Recently many lecterns facilitate multimedia presentations with built in audio systems, visuals, etc.

B. Carry out a design investigation of the physical form and features of a modern lectern. Your design investigation should include a brief exploration of modern lecterns over time.

and

C. Show graphically how you would physically modify the design of an existing lectern stand to improve its usage. Include an analysis of its shape, ergonomics, features, materials, etc.

or

Develop and graphically communicate a new concept design for a lectern which is based on a selected functional capacity or advancement and aimed at a particular target market.
Appendix 3
A 3.1 Progression of Social Development

Stage 1: Limited Interaction

The learner commences the task independently with limited interaction from others, mainly prompted by instructions. They may acknowledge communication prompts from others but have not started to work collaboratively. Most communication occurs at the beginning of tasks and/or only in tasks where the instructions are clear.

Stage 2: Supported Working

The learner actively participates in the task when it is scaffolded but works largely independently. Communication with others occurs more frequently but is limited to significant events and/or the specific information necessary to commence the task.

Stage 3: Awareness of Partnership

The learner demonstrates effort towards solving the problem. They become aware of others' roles in the collaborative problem solving process and recognise the need to engage with them. They discuss the task with others and make contributions to their understanding. The learner reports to others regarding their own activities in the task.

Stage 4: Mutual Commitment

The learner perseveres to solve the task by repeating attempts and/or multiple strategies. They share resources and information with others and can modify their communication to improve mutual and common understanding. The learner has an awareness of the performance of others and can comment on their own performance.

Stage 5: Appreciated and Valued Partnership

The learner actively participates in scaffolded and unscaffolded environments. They initiate and promote interaction with others and acknowledge and respond to contributions from others. Despite efforts, differences in understanding may not be fully resolved. The learner comments on the performance of others during the task.

Stage 6: Cooperation and Shared Goals

The learner works collaboratively through the problem solving process and assumes group responsibility for the success of the task. Feedback from others is incorporated and used to identify solution paths or modify incorrect ones. The learner can evaluate both their own performance and understanding of the task and that of others. The learner may tailor their communication and manage disagreements with others successfully, resolving any differences before proceeding on a possible solution path.
A 3.2 Progression of Cognitive Development

Stage 1: Exploration
The learner explores the problem space but this is limited to following instructions, adopting a singular approach, and focusing on isolated resources and information. Trial and error appears to be random and there is little evidence of understanding the consequences of the learner’s actions resulting in a lack of progress through the task.

Stage 2: Establishing Information
The learner identifies possible cause and effect of actions, demonstrates an initial understanding of the task concept and begins testing hypotheses and rules. They limit their analysis of the problem, using the resources and information they have. The learner remains limited in their goal setting and in generating broad objectives.

Stage 3: Sharing and Connecting Information
The learner recognises the need for more information, realising that they may not have all the required resources and shares their resources with others. They attempt to gather as much as possible and begins connecting pieces of information together.

Stage 4: Strategic Planning and Executing
The learner sees connections and patterns between multiple pieces of information, and is able to simplify the problem, narrow their goal focus and increase co-working by planning strategies with others. They adopt strategic sequential trials and increase systematic exploration and could successfully complete subtasks and simpler tasks.

Stage 5: Efficient Working
The learner’s actions appear to be well thought out, planned and purposeful, identifying the necessary sequence of subtasks. The learner identifies cause and effect, basing their goals on prior knowledge and uses suitable strategies to gain a correct solution path for both simple and complex tasks. The learner can modify and adapt their original hypotheses, in light of new information, testing alternatives hypotheses and adapting additional and/or alternative methods of problem solving.

Stage 6: Refined Strategic Application and Problem Solving
The learner’s sequential investigations and systematic behaviour requires fewer attempts for success and are completed in an optimal amount of time. The learner works with others to identify and use only relevant and useful resources and information. The learner has a good understanding of the problem and can reorganise and/or reconstruct the problem in an attempt to uncover alternative solution paths.
Appendix 4
A 4.1 Pre-Study Teacher Interview Questions

Describe the technological approach that you have developed in an effort to support the integration of technology-mediated communication into your classroom practice?

Describe the pedagogical approach that you have developed in an effort to facilitate the integration of technology-mediated communication into your classroom practice?

Based on the interactions so far, what is your perception of the pupils initial response to the integration of technology-mediated communication in the classroom practice?

What potential challenges do you foresee in the successful integration of technology-mediated communication into classroom practice? How would you overcome these?

What advice or recommendations would you give to another teacher prior to integrating technology-mediated communication in their classroom practice? Why?
Appendix 5
A 5.1 Post-Study Pupil Focus Group Questions

How did you feel about being able to use Edmodo as part of your everyday learning?

Was the learning activity on Edmodo different from your typical classroom activity?

Do you think that Edmodo was an appropriate form of ICT for this learning activity?

What influence did Edmodo have on your learning or the evidence of your learning?

How well do you think you were able to communicate your learning using Edmodo?
Appendix 6
A 6.1 Post-Study Pupil Survey Instrument

5 Point Likert-Type Scale

1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

Social Presence

Affective

1. Getting to know the other pupils gave me a sense of belonging in the class.
2. I was able to form clear impressions of some of the other pupils in the class.
3. The online or web-based communication was an excellent way of talking with other pupils.

Interactive

4. I felt comfortable conversing through the online website.
5. I felt comfortable joining in the class discussions.
6. I felt comfortable talking with the other pupils in the class.

Cohesion

7. I felt comfortable disagreeing with the other pupils while still maintaining a sense of trust.
8. I felt that my point of view was acknowledged by the other pupils in the class.
9. The online discussions helped me to develop a sense of collaboration.

Cognitive Presence

Triggering

10. The problems posed increased my interest in the class issues.
11. The class activities excited my curiosity.
12. I felt motivated to explore content related questions.

Exploration

13. I used a variety of information sources to explore problems posed in this class.
14. Brainstorming and finding relevant information helped me to resolve content related questions.
15. The online discussions were valuable in helping me to appreciate other pupils’ point of view.

Integration

16. Combining new information helped me to answer questions raised in the class activities.
17. The learning activities helped me to create explanations and solutions.
18. Reflecting on class content and discussions helped me to understand the important concepts in this class.

Resolution

19. I can describe ways to test and apply the knowledge created in this class.
20. I have developed solutions to class problems that can be applied in practice.
21. I can apply the knowledge created in this class to my work or other non-class related activities.
Teaching Presence

Organisation

22. The teacher clearly communicated the important class topics.
23. The teacher clearly communicated the important class goals.
24. The teacher gave clear instructions on how to take part in the class activities.
25. The teacher clearly communicated the important due dates and time frames for the class activities.

Facilitation

26. The teacher was helpful in finding the areas of agreement and disagreement on topics that helped me to learn.
27. The teacher was helpful in guiding the class to understanding topics in a way that helped me explain my thinking.
28. The teacher helped to keep the pupils engaged and taking part in productive discourse.
29. The teacher helped to keep the pupils on task in a way that helped me to learn.
30. The teacher encouraged the pupils to explore new concepts in this class.
31. The teacher helped to build a sense of community among the pupils in the class.

Instruction

32. The teacher helped to focus discussion on relevant issues in a way that helped me to learn.
33. The teacher gave feedback that helped me to understand my strengths and weaknesses.
34. The teacher gave feedback on time or in a timely fashion.

Supporting Discourse

Constructing

35. Online discussions supported me when forming an idea or feeling of something in my mind.
36. Online discussions supported me when expressing an idea or feeling in words or actions.
37. Online discussions supported me when giving a definite structure or shape to an idea or feeling.

Capturing

38. Online discussions supported me when examining an idea or feeling closely and carefully.
39. Online discussions supported me when combining the different parts of an idea or feeling.
40. Online discussions supported me when justifying an idea or feeling with logical reasons.

Communicating

41. Online discussions supported me when making a broad statement about an idea or feeling.
42. Online discussions supported me when suggesting a possible explanation for an idea or feeling.
43. Online discussions supported me when proposing the basis of an idea or feeling to be true.

Cogitating

44. Online discussions supported me when looking over an idea or feeling in order to correct or improve.
45. Online discussions supported me when changing the way in which an idea or feeling is organised.
46. Online discussions supported me when recognising the validity or weakness of an idea or feeling.
A 7.1 Post-Study Teacher Interview Questions (A)

Describe how the technological approach you developed to support the integration of technology-mediated communication in your classroom practice changed over time?

Describe how the pedagogical approach you developed to facilitate the integration of technology-mediated communication in your classroom practice changed over time?

Based on all interactions that occurred, what is your perception of the pupils’ response to the integration of technology-mediated communication in the classroom practice?

What challenges did you encounter in the successful integration of technology-mediated communication into classroom practice? How did you overcome these?

What advice or recommendations would you give to another teacher prior to integrating technology-mediated communication in their classroom practice? Why?

A 7.2 Post-Study Teacher Interview Questions (B)

How did you feel about being able to use Edmodo as part of your everyday teaching?

Was the teaching activity on Edmodo different from your typical classroom activity?

Do you think that Edmodo was an appropriate form of ICT for this teaching activity?

What influence did Edmodo have on pupils learning and their evidence of learning?

How well do you think pupils were able to communicate their learning on Edmodo?
Appendix 8
A 8.1 Post-Study Teacher Usability Survey

ICT Usability

1. I think that I would like to use this website frequently.
2. I found the website unnecessarily complex.
3. I thought the website was easy to use.
4. I think that I would need assistance to be able to use this website.
5. I found the various functions in this website were well integrated.
6. I thought there was too much inconsistency in this website.
7. I would imagine that most people would learn to use this website very quickly.
8. I found the website very cumbersome to use.
9. I felt very confident using the website.
10. I needed to learn a lot of things before I could get going with this website.

EPI Usability

11. I think that I would like to use this framework frequently.
12. I found the framework unnecessarily complex.
13. I thought the framework was easy to use.
14. I think that I would need assistance to be able to use this framework.
15. I found the various features in this framework were well integrated.
16. I thought there was too much inconsistency in this framework.
17. I would imagine that most people would learn to use this framework very quickly.
18. I found the framework very cumbersome to use.
19. I felt very confident using the framework.
20. I needed to learn a lot of things before I could get going with this framework.

5 Point Likert-Type Scale

1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree
Appendix 9
# A 9.1 Learning Protocols Coding Rubric

<table>
<thead>
<tr>
<th>Category</th>
<th>Code</th>
<th>Indicators</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construct</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LP01</td>
<td>Conceptualise</td>
<td>Creating a mental grasp of something to develop an idea or feeling.</td>
</tr>
<tr>
<td></td>
<td>LP02</td>
<td>Externalise</td>
<td>Giving abstract meaning to some or all elements of an idea or feeling.</td>
</tr>
<tr>
<td></td>
<td>LP03</td>
<td>Formalise</td>
<td>Applying tangible substance to practise or test an idea or feeling.</td>
</tr>
<tr>
<td><strong>Capture</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LP04</td>
<td>Analyse</td>
<td>Examining an idea or feeling in order to explain and interpret it.</td>
</tr>
<tr>
<td></td>
<td>LP05</td>
<td>Synthesise</td>
<td>Making what is known about an idea or feeling into a coherent whole.</td>
</tr>
<tr>
<td></td>
<td>LP06</td>
<td>Rationalise</td>
<td>Qualifying the importance or significance of a particular idea or feeling.</td>
</tr>
<tr>
<td><strong>Communicate</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LP07</td>
<td>Generalise</td>
<td>Describing broad application, or conclusions from, an idea or feeling.</td>
</tr>
<tr>
<td></td>
<td>LP08</td>
<td>Hypothesise</td>
<td>Suggesting a possible explanation or direction for an idea or feeling.</td>
</tr>
<tr>
<td></td>
<td>LP09</td>
<td>Theorise</td>
<td>Reasoning supporting principles to substantiate an idea or feeling.</td>
</tr>
<tr>
<td><strong>Cogitate</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LP10</td>
<td>Revise</td>
<td>Looking over an idea or feeling in part or in full to correct or better it.</td>
</tr>
<tr>
<td></td>
<td>LP11</td>
<td>Reorganise</td>
<td>Changing the way in which an idea or feeling has been formulated.</td>
</tr>
<tr>
<td></td>
<td>LP12</td>
<td>Recognise</td>
<td>Knowing how to progress or reconstruct an idea or feeling.</td>
</tr>
</tbody>
</table>
# A 9.2 Social Presence Coding Rubric

<table>
<thead>
<tr>
<th>Category</th>
<th>Code</th>
<th>Indicators</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affective</td>
<td>SP01</td>
<td>Expression of emotions</td>
<td>Conventional expressions of emotion, or unconventional expressions of emotion, includes repetitious punctuation, conspicuous capitalization, emoticons.</td>
</tr>
<tr>
<td></td>
<td>SP02</td>
<td>Use of humour</td>
<td>Teasing, cajoling, irony, understatements, sarcasm.</td>
</tr>
<tr>
<td></td>
<td>SP03</td>
<td>Self-disclosure</td>
<td>Presents details of life outside of class, or expresses vulnerability.</td>
</tr>
<tr>
<td>Interactive</td>
<td>SP04</td>
<td>Continuing a thread</td>
<td>Using reply feature of software, rather than starting a new thread.</td>
</tr>
<tr>
<td></td>
<td>SP05</td>
<td>Quoting from other's messages</td>
<td>Using software features to quote others entire message or cutting and pasting selections of other's messages.</td>
</tr>
<tr>
<td></td>
<td>SP06</td>
<td>Referring explicitly to others' messages</td>
<td>Direct references to contents of other's posts.</td>
</tr>
<tr>
<td></td>
<td>SP07</td>
<td>Asking Questions</td>
<td>Students ask questions of the other students or moderator.</td>
</tr>
<tr>
<td></td>
<td>SP08</td>
<td>Complimenting, expressing appreciation</td>
<td>Complimenting others or contents of others' messages.</td>
</tr>
<tr>
<td></td>
<td>SP09</td>
<td>Expressing agreement</td>
<td>Expressing agreement with others or content of others' messages.</td>
</tr>
<tr>
<td>Cohesive</td>
<td>SP10</td>
<td>Vocatives</td>
<td>Addressing or referring to participants by name.</td>
</tr>
<tr>
<td></td>
<td>SP11</td>
<td>Addresses or refers to the group using inclusive pronouns</td>
<td>Addresses the group as we, us, our, group.</td>
</tr>
<tr>
<td></td>
<td>SP12</td>
<td>Phatics, salutations</td>
<td>Communication that serves purely as a social function; greetings, closures.</td>
</tr>
</tbody>
</table>
### A 9.3 Cognitive Presence Coding Rubric

<table>
<thead>
<tr>
<th>Category</th>
<th>Code</th>
<th>Indicators</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Triggering</strong></td>
<td>CP01</td>
<td>Recognising the problem</td>
<td>Presenting background information that culminates in a question.</td>
</tr>
<tr>
<td></td>
<td>CP02</td>
<td>Sense of puzzlement</td>
<td>Asking questions, messages that take discussion in the new direction.</td>
</tr>
<tr>
<td><strong>Exploration</strong></td>
<td>CP03</td>
<td>Divergence--within the online community</td>
<td>Unsubstantiated contradiction of previous ideas.</td>
</tr>
<tr>
<td></td>
<td>CP04</td>
<td>Divergence-- within a single message</td>
<td>Many different ideas/themes presented in one message.</td>
</tr>
<tr>
<td></td>
<td>CP05</td>
<td>Information Exchange</td>
<td>Personal narratives/descriptions/facts (not used as evidence to support a conclusion).</td>
</tr>
<tr>
<td></td>
<td>CP06</td>
<td>Suggestions for consideration</td>
<td>Author explicitly characterises message as exploration.</td>
</tr>
<tr>
<td></td>
<td>CP07</td>
<td>Brainstorming</td>
<td>Adds to established points but does not systematically defend/justify/develop addition</td>
</tr>
<tr>
<td><strong>Integration</strong></td>
<td>CP08</td>
<td>Leaps to Conclusions</td>
<td>Offers unsupported opinions</td>
</tr>
<tr>
<td></td>
<td>CP09</td>
<td>Convergence-- among group members</td>
<td>Reference to previous message followed by substantiated agreement, Building on, adding to others' ideas.</td>
</tr>
<tr>
<td></td>
<td>CP10</td>
<td>Convergence--within a single message</td>
<td>Justified, developed, defensible, yet tentative hypotheses.</td>
</tr>
<tr>
<td></td>
<td>CP11</td>
<td>Connecting ideas, synthesis</td>
<td>Integrating information from various sources - textbook, articles, personal experience.</td>
</tr>
<tr>
<td></td>
<td>CP12</td>
<td>Creating Solutions</td>
<td>Explicit characterization of message as a solution by participant.</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td>CP13</td>
<td>Vicarious application to real work</td>
<td>Applying</td>
</tr>
<tr>
<td></td>
<td>CP14</td>
<td>Testing Solutions</td>
<td>Providing examples of how problems were solved</td>
</tr>
<tr>
<td></td>
<td>CP15</td>
<td>Defending Solutions</td>
<td>Explaining why a problem was solved in a specific manner</td>
</tr>
</tbody>
</table>
## A 9.4 Teaching Presence Coding Rubric

<table>
<thead>
<tr>
<th>Category</th>
<th>Code</th>
<th>Indicators</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organization</strong></td>
<td></td>
<td><strong>TP01</strong> Setting curriculum</td>
<td>&quot;This week we will be discussing…”</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TP02</strong> Designing method</td>
<td>&quot;I am going to divide you into groups, and you will debate…”</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TP03</strong> Establishing time parameters</td>
<td>&quot;Please post a message by Friday…”</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TP04</strong> Utilizing medium effectively</td>
<td>&quot;Try to address issues that others have raised when you post&quot;</td>
</tr>
<tr>
<td><strong>Facilitation</strong></td>
<td></td>
<td><strong>TP05</strong> Establishing netiquette</td>
<td>&quot;Keep your messages short&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TP06</strong> Identifying areas of agreement/disagreement</td>
<td>&quot;Joe, Mary has provided a compelling counter-example to your hypothesis. Would you care to respond?”</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TP07</strong> Seeking to reach consensus/understanding</td>
<td>&quot;I think Joe and Mary are saying essentially the same thing”</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TP08</strong> Encouraging, acknowledging, or reinforcing student contributions</td>
<td>&quot;Thank you for your insightful comments”</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TP09</strong> Setting climate for learning</td>
<td>&quot;Don't feel self-conscious about 'thinking out loud' on the forum. This is a place to try out ideas after all.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TP10</strong> Drawing in participants, prompting discussion</td>
<td>&quot;Any thoughts on this issue?”</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TP11</strong> Assess the efficacy of the process</td>
<td>&quot;Anyone care to comment?”</td>
</tr>
<tr>
<td><strong>Instruction</strong></td>
<td></td>
<td><strong>TP12</strong> Present content/questions</td>
<td>&quot;Bates says…what do you think”</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TP13</strong> Focus the discussion on specific issues</td>
<td>&quot;I think that's a dead end. I would ask you to consider…”</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TP14</strong> Summarize the discussion</td>
<td>&quot;The original question was…Joe said…Mary said…we concluded that…We still haven't addressed…”</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TP15</strong> Confirm understanding through assessment and explanatory feedback.</td>
<td>&quot;You're close, but you didn't account for… …this is important because…”</td>
</tr>
<tr>
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<td></td>
<td><strong>TP16</strong> Diagnose misconceptions</td>
<td>'Remember, Bates is speaking from an administrative perspective, so be careful when you say…”</td>
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<tr>
<td></td>
<td></td>
<td><strong>TP17</strong> Inject knowledge from diverse sources, e.g., textbook, articles, internet, personal experiences (includes pointers to resources)</td>
<td>&quot;I was at a conference with Bates once, and he said…You can find the proceedings from the conference at <a href="http://www%E2%80%A6%E2%80%9D">http://www…”</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TP18</strong> Responding to technical concerns</td>
<td>&quot;If you want to include a hyperlink…”</td>
</tr>
</tbody>
</table>
Appendix 10
A 10.1 Nvivo Coding Matrix Analysis Teacher Interviews

1. Technological Approach
   1.1. ICT Policy in Schools
       1.1.1. Mobile Phones
   1.2. ICT Access in Schools
       1.2.1. In School
           1.2.1.1. Classroom
              1.2.1.1.1. Technology Room
              1.2.1.1.2. Computer Room
           1.2.1.2. Classtime
              1.2.1.2.1. Whole Class
              1.2.1.2.2. Partial Class
              1.2.1.2.3. Extra Class
       1.2.2. At Home
           1.2.2.1. Restricted Access
           1.2.2.2. Unrestricted Access
   1.3. ICT Usage in Schools
       1.3.1. Desktop Version
       1.3.2. Mobile Version

2. Pedagogical Approach
   2.1. Selecting Content
       2.1.1. Teaching Activities
           2.1.1.1. Planning Schemes
           2.1.1.2. Planning Lessons
              2.1.1.2.1. Introduction
              2.1.1.2.2. Presentation
       2.1.2. Learning Outcomes
           2.1.2.1. Soft Skills
           2.1.2.2. Hard Skills
       2.1.3. Assessment Tasks
           2.1.3.1. Digital Badges
   2.2. Setting Climate
       2.2.1. Design of Learning Environment
       2.2.2. Delivery of Educational Transaction
   2.3. Supporting Discourse
       2.3.1. Posting
       2.3.2. Commenting
       2.3.3. Hashtagging
   2.4. Establishing Presence
       2.4.1. Social Presence
       2.4.2. Cognitive Presence
       2.4.3. Teaching Presence
           2.4.3.1. Monitoring Online Behaviour
3. Pupils Response

3.1. Technology Enhanced Learning
   3.1.1. Familiarity
   3.1.2. Practicality
       3.1.2.1. ICT for Learning

3.2. Technology Mediated Communication
   3.2.1. Motivation
       3.2.1.1. Environment
       3.2.1.2. Assignment
   3.2.2. Participation
       3.2.2.1. Confident
       3.2.2.2. Hesitant
   3.2.3. Interaction
       3.2.3.1. Social Interactions
       3.2.3.2. Cognitive Interactions
       3.2.3.3. Teacher Interactions

4. Challenges

4.1. ICT Access in Schools
   4.1.1. Equal Opportunities

4.2. ICT Uptake in Schools
   4.2.1. Endorsement
       4.2.1.1. Pupil Dimension
   4.2.2. Engagement
       4.2.2.1. Staying on Task
       4.2.2.2. Staying in Task

5. Recommendations

5.1. Technological Approach

5.2. Pedagogical Approach

6. Miscellaneous

6.1. Teaching
   6.1.1. Tracking Development
   6.1.2. Building Relationships
   6.1.3. Connecting Teachers

6.2. Learning
   6.2.1. Increased Interaction
   6.2.2. Extra Contact Time
   6.2.3. The Middle Ground

6.3. ICT
   6.3.1. ICT Skills & Abilities
       6.3.1.1. Positive Online Behaviour
A 10.2 Nvivo Coding Matrix Pupil Focus Groups

1. ICT & School Activity
   1.1. Interest
   1.2. Motivation
   1.3. Engagement

2. ICT & Classroom Activity
   2.1. Roles
   2.2. Support
   2.3. Interaction

3. ICT & Learning Activity
   3.1. Content
   3.2. Outcomes
   3.3. Development

4. Ability to Evidence Learning
   4.1. Ideas
   4.2. Process
   4.3. Solutions

5. Ability to Communicate Learning
   5.1. Posts
   5.2. Comments
   5.3. Hashtags
Appendix 11
A 11.1 Frequency of CoI and PD Coding

Percentage of CoI & PD Codes Assigned by Element

Distribution of CoI & PD Codes Assigned by Element
A 11.2 Frequency of Learning Protocols Coding

Percentage of LP Codes Assigned by Category

Distribution of LP Codes Assigned by Category
A 11.3 Frequency of Social Presence Coding

Percentage of SP Codes Assigned by Category

Distribution of SP Codes Assigned by Category
A 11.4 Frequency of Cognitive Presence Coding

Percentage of CP Codes Assigned by Category

Distribution of CP Codes Assigned by Category
A 11.5 Frequency of Teaching Presence Coding

**Percentage of TP Codes Assigned by Category**

![Pie chart showing the distribution of TP codes by category. Organisation takes up 24%, Facilitation takes up 25%, and Instruction takes up 51%.]

**Distribution of TP Codes Assigned by Category**

![Bar chart showing the distribution of TP codes assigned to each participant (S_01 to S_07). Each bar is divided into sections representing Organisation, Facilitation, and Instruction.]
A 12.1 Frequency of CoI and PD Coding (S_01)

Trend of CoI & PD Codes Assigned by Element (S_01)

Percentage of CoI & PD Codes Assigned by Element (S_01)
A 12.2 Frequency of CoI and PD Coding (S_02)

Trend of CoI & PD Codes Assigned by Element (S_02)

Percentage of CoI & PD Codes Assigned by Element (S_02)
A 12.3 Frequency of CoI and PD Coding (S_03)

Trend of CoI & PD Codes Assigned by Element (S_03)

Percentage of CoI & PD Codes Assigned by Element (S_03)
A 12.4 Frequency of CoI and PD Coding (S_04)

Trend of CoI & PD Codes Assigned by Element (S_04)

Percentage of CoI & PD Codes Assigned by Element (S_04)
A 12.5 Frequency of CoI and PD Coding (S_05)

Trend of CoI & PD Codes Assigned by Element (S_05)

Percentage of CoI & PD Codes Assigned by Element (S_05)
A 12.6 Frequency of CoI and PD Coding (S_06)

Trend of CoI & PD Codes Assigned by Element (S_06)

Percentage of CoI & PD Codes Assigned by Element (S_06)
A 12.7 Frequency of CoI and PD Coding (S_07)

Percentage of CoI & PD Codes Assigned by Element (S_07)

Density

Percentage of CoI & PD Codes Assigned by Element (S_07)
## A 13.1 Factor Pattern Matrix for CoI Survey

<table>
<thead>
<tr>
<th>Question</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q_01</td>
<td>-.530</td>
<td></td>
<td>-.508</td>
<td></td>
</tr>
<tr>
<td>Q_02</td>
<td></td>
<td>-.711</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q_03</td>
<td></td>
<td>-.663</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q_04</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q_05</td>
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<td></td>
<td>.691</td>
<td></td>
</tr>
<tr>
<td>Q_06</td>
<td></td>
<td></td>
<td>.599</td>
<td></td>
</tr>
<tr>
<td>Q_07</td>
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<td></td>
<td>.705</td>
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</tr>
<tr>
<td>Q_08</td>
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<td>.550</td>
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<tr>
<td>Q_09</td>
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</tr>
<tr>
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<td>.560</td>
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<tr>
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</tr>
<tr>
<td>Q_34</td>
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<td>-.626</td>
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<td></td>
</tr>
</tbody>
</table>

| Eigenvalue | 12.47 | 3.64 | 2.00 | 1.86 |
| % of Variance | 36.67 | 10.70 | 5.89 | 5.46 |
| Reliability | 0.89 | 0.94 | 0.81 | 0.78 |

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalisation.a

a. Rotation converged in 11 iterations.
### A 13.2 Pattern Matrix for CoI and PD Survey

<table>
<thead>
<tr>
<th>Question</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>Q_02</td>
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<tr>
<td>Q_03</td>
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<td>0.424</td>
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<td>Q_04</td>
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<td>Q_07</td>
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Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalisation.a

a. Rotation converged in 10 iterations.
A 13.3 Relationship of 3 Factor EFA Model (CoI)
A 13.4 Relationship of 3 Factor EFA Model (CoI & PD)
A 14.1 Design and Implementation

The purpose of the preliminary interviews was to consolidate teachers understanding of ‘what is going to happen’. Questions were designed to verify the steps taken to support the integration of TMC into classroom practice and to benchmark the initial perceptions, challenges and the recommendations associated with integrating TMC. The post-study interview was conducted in an effort to determine ‘what did happen’. In an effort to aid the coding process, the questions asked were categorical in nature. Appendix 7 shows the overall matrix of codes. In answering the following question:

* Describe the technological approach you have developed in an effort to support the integration of technology-mediated communication into your classroom practice? *

The findings present three core themes as developing during the cycles of analysis, these include ICT policy in schools, ICT access in schools and ICT usage in schools. Each theme will be presented and discussed with final conclusions reporting on the interplay between the core themes as identified in both the pre- and post- interviews.

When describing the technological approaches developed to support the integration of TMC, 5 of the 7 teachers interviewed acknowledged the schools ICT policy, with specific reference to the use of mobile phones in schools, as being a key contributor. For example, the extract presented below as taken from T_02 (pre-study), indicates how the schools ICT policy influenced both the choice of room in which the research intervention was carried out and the method of sharing the evidence of their learning.

*When it came to the technological approach the school itself has a policy that you can’t, no phones are allowed to be used on the premises. So that kind of ruled out the use of; of am, the smartphone app or uploading pictures from your phone. So we had to take the approach of ok, we couldn't do it here in the construction room, we had to do it in the actual computer rooms. So another reason was we had to find a class that suited us where the computer rooms were free, because the computer rooms actually have a system where there's digital cameras hooked up to the cameras or hooked up, sorry, to the computers, where if the pupils make a sketch or they want to upload a picture or a video or something like that, they're actually able to take the picture there and then with the camera and upload it straight to the site rather than having to worry about using their phone or going home using their phone uploading it and trying to backtrack. So they can do everything there (T_02).*
This gave rise to ICT access in schools being identified as the second theme which influenced the teachers’ development of technological approaches to support TMC. Within this, teachers discussed the pupils’ access to ICT both in school and at home. As a theme, ICT access in schools consisted of the classroom in which the research intervention was integrated into (i.e. technology room, computer room), the amount of class time allocated to the intervention (i.e. whole class, partial class, extra class), and the pupils capacity to participate in the intervention (i.e. restricted, unrestricted).

The extract presented below as taken from T_05 (pre-study), indicates that in certain schools, ICT access was a concern in relation to the quality of work being produced.

*The students access Edmodo from both home and school. We, we participate in a class once a week, Friday’s class I have assigned for just Edmodo engagement. So, since we started the assist am, assignment am, every Fridays class the students aren't actually at the drawing boards or the tables, they’re at the computers that are in the DCG room. Am, initially when they started out, they were only using their phones and what I found was it's very hard to make out some of the homework activities 'cause the phones are of poor quality. Some of them would have older phones you know and the camera is of poor quality so, for the purposes of the assignment, we’re going to use the visualiser and computer to take the pictures of everything (T_05).*

However, as presented in the following extract taken from T_02 (pre-study), in other schools, ICT access was a greater concern relating to the inequality it could produce.

*... the school was concerned about not putting too much pressure on students to do this at home because every student has a different background and not everyone is going to have the facility to be able to log on from home (T_02).*

Although, this was an initial concern, pupils’ access to ICT did not impact the study. Therefore, with a particular focus on the desktop and mobile versions of Edmodo, ICT usage in schools was the final theme to be identified as contributing to teachers’ integration of TMC. This is demonstrated in the extract taken from T_04 (pre-study).

*Thursday and Friday classes are both set in a computer room so they have access to Edmodo [...]. They also use it at home. Basically, they have their computers at home and they've downloaded the app so they all use that pretty much whenever they want. Am... and that's pretty much their access to it. [...] They all do have access yes. I made sure of that before I started that they all had smartphones or android phones that they could download the app and they all had internet available, ready available at home to use it (T_04).*
In addition to understanding technological approaches developed by teachers in an effort to support the integration of TMC into their classroom practice, it was vital to also understand their pedagogical approaches. In answering the following question:

*Describe the pedagogical approach you have implemented in an effort to support the integration of technology-mediated communication into your classroom practice?*

The findings present four themes as developing through the cycles of analysis, these are selecting content, setting climate, supporting discourse and establishing presence, with each theme having various sub-codes which contribute to the emergent themes. For example, when describing the pedagogical approaches developed to support the integration of TMC, teachers recognised the importance of selecting content, while referencing the activities of teaching, outcomes of learning, and tasks of assessment. The extract presented below taken from T_06 (post-study), indicates how Edmodo’s asynchronous nature has changed teachers pedagogical approach to lesson planning.

> If I can have the homework checked before coming into school and three or four times, there were issues with the homework. I am able to comment on it like and the class know like, I’ve, I had it explained to the class that when you post something I will get an email so I'll be able to reply to you within a minute or two, so when they post their problem, they just left their computer screen on. I'd get back to them within a minute or two and then they can, we can have a little conversation about it and then they go “oh yeah, I see where I'm going wrong”, and a half an hour later they'll post the right one and, to be able to do that, to be able to contact them at home on, on Edmodo and solve the problem when they are at home, they can rectify the problem and you're able to move on, you're constantly moving forward in every class, that's something that teachers really need to tap into, because this thing of going back over homework for ten minutes when you don't have to, like, you have, it's not that you're not going over the homework, you've the homework gone over when they're at home and you're constantly moving forward with new material, it's, that, that alone it's, it's hugely beneficial like, hugely (T_06).

Though selecting content was considered to be important to all teachers interviewed, the most sourced theme identified as contributing to the pedagogical approaches they implemented in an effort to facilitate the integration of TMC was setting the climate. Within this, teachers discussed how the design of the learning environment and the delivery of the educational transaction were influencing factors in setting the climate. This issue is clearly presented in the following extract taken from T_02 (pre-study).
Well initially, the first class especially when we were setting up the accounts, students kind of, ’cause traditionally it tends to be, “ok go on the computers, just keep out of my way for a while”, whereas now we’re trying to structure it and actually do something that’s really productive and they’re not used to that kind of environment so you know they got a little bit giddy and got a bit, you know, “we’ll just set it up real quickly and we’ll go play some games or go on iTunes or something”. So it was kind of to get them in the mind set of we’re here, this is what we have to do, ok I don’t want anyone playing games, I want everyone on Edmodo, I want everyone researching, and initially it kind of, it took maybe a class and a half to get them in the mind set of “ok no we actually are, we’re here to work, we’re not here to mess, I’m not here to have a chat with my buddies, I’m not here to log on Facebook”, so I just kind of, that was the hardest thing was getting them to think “ok, we’re going to the computer room but it’s not, oh yes we’re going to the computer room, it’s a free class”, it’s “we’re going to the computer room, we actually have some serious research to do, we have to do some work and it’s not a mess class it’s actually, it’s the same as being in the actual classroom”. You have your work you have to do, you know, there’s a set amount of work that you should get done in this class and there isn’t any time for messing in between (T_02).

Subsequently, to help set the appropriate climate for teaching and learning, and with a particular focus on the use of posts, comments, and hashtags, supporting discourse was the next theme to be identified as contributing to teachers’ integration of TMC. For example, as was discussed in the following extract taken from T_04 (pre-study).

So at the start I set aside two classes for setting up, the first was to set them up with their accounts, to join the group, to teach them how to, how to post, how to access their libraries, how to upload, how to attach files, all that stuff. Am… then in the second class I went through the hashtagging with them. So what I did was, I created a PowerPoint for them and split the 12 hashtags in to groups of 3 and explained each of them in a structured form so that they'd understand when they finish the 3 they’d be able to ask questions before moving on to another 3. Am… and this helped as, I think in understanding, in their understanding of the hashtags ’cause I found that, you know […] the words were quite difficult to get a grasp of […] but I think they got a, kind of a clear view or a clear understanding of what they need to do now, and am… I've also tried to, when I'm posting put in the hashtags myself so they get an example of how I'm using it and kind of try and use that themselves as well. They kind of have a clear example of how I'm using it and how they should use it. Am… and just kind of imitate that kind of a, a hashtagging sequence I suppose. Am… that's what I've tried to do mostly with that anyway. I've put that PowerPoint of the hashtags on Edmodo in their library so, in their, I think it's their school bag or their briefcase or something along those lines on Edmodo. Am… so they have access to that whenever, so when they are posting I've encouraged them to, before they settle on a hashtag to check, check that PowerPoint to make sure they're posting the right or they have the right meaning or understanding of the hashtag they're about to put (T_04).
In addition, teachers attempted to relate the use of posts, comments, and hashtags to everyday social networking applications that pupils would already be familiar with.

I started to show them about targeting posts and attaching the hashtags then and eh, they sort of struggled with the hashtags for a while until I asked them if they use Instagram, and next thing they all ended up having Instagram accounts. So the purpose of posting a picture on Instagram, I have an Instagram account myself like, so I just quickly logged on the computer, showed them a picture, the last one that I had up, I think I was after giving all day Saturday polishing the car and I took a picture of it and I, and it was hashtagged, just hashtag Audi say. So that was the caption of the picture. So they then were able to create the link that this hashtag was now what they, was the capstone of their, their post like. So once they read that then and once they understood that they were like, the hashtags they used exactly the same as Instagram, they were able to just go right, they read down through the hashtags, I was, I put them up on the projector and they sort of read down through them and they were able to attach the hashtag then no problem at all. They didn't see any problem with that and they knew which one it was straight away. Once they understood that it was to highlight the post (T_05).

Lastly, as the following extract taken from T_04 (pre-study) presents, the final theme to be identified was establishing presence, (social, cognitive and teaching presence).

... it did improve the way everybody interacted then in class and, am, it just allowed them to post their work and to be able to get feedback on it, rather than when I didn't have time in a single class and then, I think some students might think, “he's not giving me any time”, where there actually physically isn't time in the class. So it just improved, just the whole workings of the class and how we just went about doing, going through our topics in general and I think they appreciated that and there was, one thing that I noticed was there was a lot more respect from the students when they seen that I was giving up my time to post online and then they were giving their time and you could see then that everybody was putting more into the subject. Am, so then, there was a lot more appreciation from everyone, myself and them included (T_07).

As presented in the following extract taken from T_03 (pre-study), monitoring online behaviour was a greater rationale for establishing teaching presence in other schools.

So, any notification am, that comes up on Edmodo goes straight to my phone. Am, whether it be a pupil commenting am, liking a post or actually posting themselves, I know straight away what they have done. Am so, that way I'm able to monitor the students’ progress, I can see anything, I am, explicit comments or posts that isn't relevant so, it's just a great way of monitoring it because I have my phone with me the whole time. I might not have access to a computer or a laptop so I just find it great way of, of monitoring it (T_03).
A 14.2 Beliefs, Attitudes and Values

In response to being able to use Edmodo as part of their everyday learning, pupils discussed three core themes which consisted of interest, motivation and engagement. When asked if the activity on Edmodo was different from typical classroom activity, pupils responded by acknowledging the variation in roles, support and interaction. Subsequently, pupils were asked if Edmodo was an appropriate form of ICT for this activity, in answering this question they discuss content, outcomes and development. However, for the purpose of this section of the findings, the focus is on the fourth and fifth categories found, i.e. pupils’ ability to evidence and communicate learning. The findings present themes relating to ideas, process and solutions as developing through the cycles of analysis, when pupils were answering the following question:

What influence did Edmodo have on your learning or the evidence of your learning?

For example, the extract presented below as taken from P_67 (S_05), indicates how the spatial and temporal independencies provided by Edmodo allowed pupils more time to give better feedback, which resulted in the development of more robust ideas. As the second extract from T_05 (post-study) shows, the teacher echoed this opinion.

I got a bit off every single person here and it helped. If I'd just did it on my own, it would have been very simple and nothing too fancy but everyone's input really helped and I think Edmodo really helped because if you just say, if you ask for an idea on the spot, they are going to give whatever pops into their mind but if you say, if you ask it on Edmodo they've time to think about it, like ok I can make that better maybe I'll suggest them this and this, if there wasn't Edmodo you'd be like, oh I'll just give him anything that'll do (P_67).

... they know themselves that Edmodo upped the standard of work and they knew themselves that they were thinking about work differently, they were spending more time because they were allowed more time. If you're given more time to answer a question, you're going to answer it better, obviously. If you're given 30 seconds in a class, you, everyone, you're on the spot, you're starting to panic, everyone is looking at you waiting for an answer and you just spit out something that might not even make sense and they, they said that to me, I didn't tell them that they were doing that, they were like, when you're allowed sit back and actually think about the answer and you know, you're not putting pressure on us to do it in a minute, they said when you have 2 or 3 days, you're able to produce a way better answer so you're able to give [peers] way better feedback (T_05).
This led pupils to discuss the influence Edmodo had on the process of their learning. For example, the extract presented below as taken from P_17 (S_02), indicates how the process of working iteratively, uploading posts and comments, collaborating with others and subsequently adding data files (evidence) changed their views of learning.

It [Edmodo] kind of makes you realise as well there's not just, there's not just like the one answer, the right answer to it like, as in, in the book as I was saying like, if you were to take it down it would just be that's the answer, that's what you have to write like, you wouldn't think about it like (P_17).

As is shown in the following extract taken from T_02 (post-study), this pupils’ view is supported by their teacher, who observed the effect it had on the learning process.

I know that without it, it would have been the same two or three answers say from the book or online or from the notes copy, just reproduced over and over again kind of like a rote learning system. Whereas with Edmodo they kind of took it on themselves and were interested in finding out more stuff, working on, working through, finding you know, more appropriate answers, finding out all the information rather than just taking what's given (T_02).

Therefore, with a specific focus on the amount of work demonstrated, the following extracts from P_66 (S_05) and T_05 (post-study) reveals the final theme identified was the influence Edmodo had on the solutions presented as evidence of learning.

... if you're not, weren't on Edmodo you could have just thrown a sheet together and a few sketches, I, you know without putting effort into it but like when it's going online it's there like, like it's there forever like, you can look back on it, people can look back on it as well like, if it was in a folder you can just throw it away, hide it in a folder, it's going to be like, you have loads of sheets in the folder like, it's going to be hard to get in, but like when it's on Edmodo it's there like and you're nearly proud of looking back on it (P_63).

I think it encourages everyone to do more, do, your, like, going back to, to talking to the [class] after the DCG project was finished and I said, I asked them like, did, did, does Edmodo encourage you to do better work and they were kind of going “ya it does”, and I said how and they said well “you're looking at everyone else's work so you know the standard that is being set and you want to keep up with it”, but they said “if we were just bringing in our sheets to show you, you'd do enough and you'd go ah he'll be happy with that”, but the fact that they are kind of, even though they are not in competition, it is kind of competition to keep the standard of work as high as they can like, so it encourages them to do better work in that respect (T_05).
In addition to understanding the influence Edmodo had on the pupils learning and the evidence of their learning, it was important to also understand the pupils’ ability to communicate their learning using Edmodo. In answering the following question:

*How well do you think you were able to communicate your learning using Edmodo?*

The findings present three core themes as developing during the cycles of analysis, these include the pupils’ ability to post, comment, and hashtag posts and comments. Each theme was significantly referenced and distinctly acknowledged by all schools. It was found that in all schools pupils were confident in their ability to both post and comment, as were teachers, however, they were more hesitant in the use of hashtags. For example, the extract presented below as taken from P_02 (S_01), indicates how the language used to describe the hashtags was difficult because it was new to pupils.

... they were big, long words now that you’ve never seen before so (P_02).

However, the following extracts taken from P_17 (S_02), P_48 (S_03), and P_70 (S_05) respectively, indicate that with time pupils became familiar with the hashtags.

* I kind of understood it then like at the end, like why the lads were actually putting up hashtags and stuff. [...] Like the lads would put up like, am, such a thing like saying #analyse like, like if they want you to analyse it like to see what it like, what's wrong with it or what's right with it or whatever (P_17).

* Ya, some of them were confusing, we would probably need a few more weeks to get used to them more [...] but I think we would get used to them (P_48).

* I did kind of, there was a couple that they were slightly easier to understand, it was kind of am, you could use this to say, this is what I did or the hashtags were an overall summary of what you've done, that's I suppose, that's what I kind of used them for but then again they were hard to understand (P_70).

In addition, pupils identified the potential of hashtags and their influence on learning.

* Normally when you put up a hashtag, you just put up something that barely means anything or something that is pretty vague, that is vaguely attached to what you're doing [...] but this way you actually think about why, about what this post has to do with the 12 hashtags and which one best suits it (P_47).*
As presented in the following extract as taken from T_07 (post-study), teachers also identified the potential of hashtags and their influence on learning, but acknowledged the difficulties pupils encountered, suggesting they could have explained them better.

... the fact that I, like bearing in mind here that they were only using Edmodo for a short period, I think that they probably would have over time. I could have explained them better and like anything once it's used several times, it will catch on eventually but the first impressions was that, it was difficult for them to understand the hashtags, it probably was a lot for them to, getting them to post in the first place and then trying to get hashtags included at the start. It's a lot to expect anyways but for me [...] I could see the full potential. ... it did add to the post because sometimes instead of putting in a load of text, as I said previously, sometimes it was hard to assess students because you wouldn't know whether they were posting a photo simply just to post a photo or to ask me a question but sometimes they just posted one photo and one hashtag and they didn't say anything else and I knew exactly what they wanted to get across to me, so ya it did. When they were used correctly by a few students and they did work ya, I was able to use them when I commented back and I think they understood am, what I was trying to get across (T_07).

Hence, the perception of both teachers and pupils is that with time and experience, hashtags can be used as a powerful medium to communicate and reflect on learning. This perception is articulated in the following extract taken from T_01 (post-study).

There's a great benefit in hashtagging, there's no two ways about it because what you've just done is you've thought about what you've actually said and what kind of process you've gone through [...] because they have described something and they have thought about it. So, by getting them to hashtag it, they've come up with a post, they've thought about the post, now they're actually thinking about what they're trying to communicate with the post. So, they start to question themselves, they start questioning themselves as well, why am I putting up this post, what am I looking for by putting up this post [...] and they just start analysing them, breaking down what they're looking for and then the hashtags then kind of, it forces, it gets them to think back over what they've said to try and communicate what they're trying to look for. ... when I can, when I can see what they hashtag, means I can see what the pupils are thinking. So if its #conceptualise maybe they're trying to show what their idea is. Whereas if its #revise, maybe they're looking for somebody to revise their idea with, and then it kind of, it gives the teacher and whoever looking at it an idea of what the pupil or the other person is actually looking for in theirs and what they're actually doing with there's I suppose (T_01).

The findings suggest that pedagogy, not technology will have a greater impact on the quality of learning and efficacy of teaching when supporting discourse using TMC.
A 15.1 Accompanying Data Files