University of Strathclyde, School of Education.

Critical thinking in a Community of Inquiry: Applying a socio-constructivist framework to problem-based learning tutorials in a Scottish medical curriculum, to investigate critical thinking and the factors that influence this.

A thesis presented in part fulfillment of the requirements for the degree of Doctor of Education.

By

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This thesis is the result of the author's original research. It has been composed by the author and has not been previously submitted for examination which has led to the award of a degree.

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Glossary.

The following definitions are used in this thesis and are listed here to aid the reader. Unless otherwise specified, they represent my own definitions.

Term	Definition
Abstract thinking	Concerned with things not directly experienced.
Affective thinking	To do with feelings or emotions; related to caring thinking (Lipman, 1995), in the sense of caring about - thinking about things or people that are valued (*ibid*.)
Argument	A combination of two forms of statement: a conclusion and the reasons allegedly supporting it (Browne & Keeley, 2007)
Assumption	A statement or reason that is not made explicit.
Belief	A view held by the thinker, which is accepted without the thinker necessarily having examined the grounds, or reasons, for that view.
Caring thinking	A feature of Lipman's (1995) community of inquiry; combines affective and conative, or active, thinking.
Clinical reasoning	Reasoning in the clinical environment.
CMC	Computer-mediated communication.
Cognitive presence	A proxy for critical thinking. 'The extent to which the participants in … a [CoI] are able to construct meaning through sustained communication ' (Garrison *et al*, 2000)
Community of Inquiry	A group of individuals who work together to undertake an inquiry – or solve a problem – and who do so primarily through the vehicle of discourse (Lipman, 1988; see 3.3.8).
Community of Practice	Participants share a common purpose, but this is not necessarily learning or inquiry (Lave & Wenger, 1991; see 3.3.8)
Conative/active thinking	Concerned with impulses and actions; related to caring thinking (Lipman, 1995), in the sense of taking care of something.

Term.	Definition.
Conclusion	A claim or judgment arrived at based on specific reasons.
Creative thinking	Inventing, associating, suggesting alternatives, making analogies, [and] formulating hypotheses (Daniel & Auriac, 2009).
Critical appraisal	The critical consideration and evaluation of a writer/speaker's reasons for arriving at specific conclusions.
Critical thinking	Various definitions and conceptualisations are discussed in Ch. 3. Critical thinking may be viewed as a cycling between the internal world of the thinker's mind (Garrison, 1991, 1992) and the external, world (*ibid*.) of social interaction. The internal and external world respectively correlate with the creative thinking and validation components of critical thinking. Superimposing a conceptualisation of critical thinking as a five-stage problem-solving process (Dewey, 1933), where a problem may be an inadequate understanding (Garrison, 1991) of a biological or clinical concept, the problem is identified in the external world and initially explored via information exchange; consideration of the problem then moves to the internal world, as the thinker seeks to create possible solutions and integrate these with his existing knowledge construction; then the thinker returns to the external world to validate his thinking and integrate his new knowledge construction, or understanding of the concept, by applying it in the external world.
Dialectical thinking	Where reasoners pit two or more opposing points of view in competition with each other, developing each by providing support, raising objections, countering those objections, raising further objections, and so on. (Paul, 1995).
Dialogue	Verbal interaction between 2 individuals.
Discussion	Verbal interaction between more than 2 individuals.
Discourse	A verbal interaction whereby the participants engage in purposeful sharing of ideas and conclusions in the expectation of constructive criticism (see 3.3.6). Also, student and facilitator output during a PBL tutorial; incorporating utterances, tone and non-verbal interactions, as determined respectively from the transcript, audio- and video-recording of the session.

Term.	Definition.
Divergent thinking	The generation of multiple solutions or ideas; associated with creativity, and with the brainstorming step of PBL (Maudsley & Strivens, 2000b).
Expertise	The possession and command of a body of knowledge that defines a field or discipline (3.5.1).
Facilitation	Making something possible or easier by means of one's specific instruction, manner, etc.
Inference	A conclusion that is not made explicit.
Judgment	Implies a deliberate choosing of one thing over another: evaluation of options is necessary, but not sufficient to make a judgment; one also needs to have an impetus for making the judgment.
Logic	Concerned with the quality of reasoning in an argument (Kurfiss, 1988).
Meta-cognition	Knowledge and cognition about cognitive phenomena (Flavell, 1979, p.906). A critically reflective cognitive activity involving awareness and monitoring of one's thought processes; component constructs include meta-cognitive knowledge, meta-cognitive experience, and appraisal or judgment of one's thinking.
Mono-logical thinking	Thinking that is conducted within one point of view or frame of reference (Paul, 1995, p.543).
Multi-logical thinking	Thinking that sympathetically enters, considers, and reasons within multiple points of view (Paul, 1995, p.544).
Self-directed learning	A comprehensive activity that encompasses setting the goals for learning, managing external factors to maximise learning, and employing the necessary intellectual skills to ensure that learning is actually achieved.
Reasons	Statements made in support of a conclusion. Equivalent to grounds or data.
Reasoning	Making statements in support of a conclusion. Making clear the mental steps by which one arrives at a conclusion (Paul, 1995).

Term	Definition
Reflective thought	Active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends (Dewey, 1933, p. 9; 2009, p.6).
Scaffolding	Ways of supporting learners in unfamiliar environments (Simons & Ertmer, 2005, p.4). May be hard, viz. 'static … and planned in advance (Saye & Brush, 2002, p.81) or soft, viz. 'dynamic and situational' (*ibid*., p.82).
Social presence	A construct in the community of inquiry concept: refers to the social environment and the social interactions between members of the community.
Teaching presence	A construct in the community of inquiry concept: refers to the design of the educational experience and to the facilitation of learning (Garrison *et al*, 2000).
Utterance	Individual contribution to the PBL discourse, generally defined by a change of topic, new speaker, or a natural pause.
Warrant	A justification of the way in which the data/grounds lead to the claim being made; it effectively elaborates why the reason does indeed offer support for the claim.
ZPD	Zone of proximal development (Vygotsky, 1978, p.86) Learning challenges that are beyond the current capabilities of the learner working in isolation, but achievable if the learner is guided, or if he collaborates with more capable peers (3.3.8).

Abstract

In medical education, critical thinking is held to underpin the key professional skills of clinical reasoning, clinical judgment and decision-making. The promotion of critical thinking is an intended learning outcome for the problem-based learning (PBL) component of medical curricula, but there is limited empirical evidence for critical thinking during PBL tutorials. Existing studies do not explicitly address the role of social interactions between group members, or the effect of scaffolding, on enabling or impeding critical thinking. Application of an adapted, socio-constructivist Community of Inquiry (CoI) framework allowed these issues to be addressed.

The adapted CoI framework incorporated three constructs: cognitive presence, a proxy for critical thinking; social presence, reflecting the social environment and social interactions between CoI members; and teaching presence, reflecting hard and soft scaffolding. Six PBL groups were recruited from the early years of a Scottish medical curriculum. For each group, a two-hour PBL tutorial featuring two different scenarios was recorded and transcribed. The twelve discourses were subjected to interpretivist analysis, with contextual coding of utterances.

From a CoI perspective, critical thinking was a function of the community; individual members generally contributed just one or two aspects of critical thinking per utterance. Different aspects of critical thinking were associated with different steps of the PBL process. There was no evidence for sustained progression through stages of critical thinking. The specific PBL context promoted the creative thinking component of critical thinking, and information-gathering. Social presence was evident throughout, and likely facilitated discourse, which in turn enabled aspects of critical thinking. Teaching presence manifest differently in the various steps of the PBL process and between discourses, the latter reflecting facilitator style, scaffolding interventions by students, and the specific scenario. The findings have implications for facilitator training, student induction, and scenario design.

Chapter 1. Setting the scene: The professional context.

1.1. Introduction.

This thesis describes an interpretivist study designed to investigate whether there is evidence for critical thinking by undergraduate students in a Scottish medical curriculum that uses problem-based learning (PBL) as a mode of delivery in the first two years of the five-year curriculum. When the study was conceived, PBL also featured in the third year of the curriculum, but this was conducted in a hospital setting and was less accessible. The focus of the study was therefore PBL in Years 1 and 2 of the featured curriculum.

This first chapter provides an overview of the thesis structure, then goes on to set the professional context for the study.

1.2. Structure of the thesis.

Chapter 1 defines PBL and outlines the model employed at the particular Scottish medical school featured in this study; it describes the adoption of PBL-based curricula by medical schools abroad and within the UK; and the development and components of the featured PBL-based medical curriculum.

For clarity, the literature review is presented as three chapters. Chapter 2 is relatively brief and examines the literature on some intended learning outcomes (ILOs) for PBL-based curricula; in particular, the acquisition and application of knowledge, but also ILOs relating to self-directed learning, communication skills and team-working. The chapter critically reviews evidence that these ILOs are met.

Chapter 3 provides a critical review of the literature on critical thinking, leading to the development of a conceptual framework for this study. The chapter begins by describing the concept of thinking, and distinguishes between different types of thinking. Various conceptualisations of critical thinking are critiqued for their relevance to clinical medicine, medical education and/or PBL. Socio-constructivism, and the community of inquiry (CoI), with its component constructs of cognitive, social and teaching presence, are identified as relevant theoretical frameworks for this study. The chapter concludes with a description of the conceptual framework employed.

Chapter 4 goes on to discuss that critical thinking is generally considered to be a desirable graduate attribute; and examines why the medical profession views critical thinking as a necessary attribute for medical students: essentially because of its relationship to clinical reasoning, clinical judgement and decision-making. The chapter concludes with a critical review of existing research into critical thinking by medical students in PBL-based and PBL-containing curricula. This leads to identification of a significant professional issue which defines the research aims and questions.

Chapter 5 describes the interpretivist paradigm within which this study was conducted. Participants were students from the featured Scottish medical curriculum, in Years 1 or 2 during session 2007-8, when data collection took place. The data comprise video- and audio-recordings and verbatim transcripts of a variety of PBL discourses; of which there are approximately two hours for each of six PBL groups. The chapter specifies the study design, including data collection methods, the evolution of the coding scheme, and the rationale for coding decisions. Ethical and data protection issues are also addressed.

Chapters 6 and 7 present the analysis and interpretation of individual PBL discourses. The strategy is to detail in Chapter 6 the findings from two discourses involving a single Year 1 PBL group; in Chapter 7, the findings from the remaining discourses are discussed relative to these first two, with similarities and differences highlighted.

In Chapter 8, cross-cutting themes arising from the data analysis are critiqued in relation to the research questions.

Chapter 9 is the Discussion, which picks up themes from the critical literature review and the methodology chapters, and considers them from the retrospective vantage point of having applied a socio-constructivist CoI Framework to study critical thinking in the context of PBL tutorials in the early years of the featured Scottish medical curriculum.

Finally, Chapter 10 summarises the main conclusions and limitations of the study; addresses its significance in the specific professional context, namely the featured Scottish medical curriculum and the UK medical education community; and suggests areas for future research.

As stated earlier, the professional context of the study is the delivery of undergraduate medical education: specifically, in a Scottish medical school with a curriculum in which PBL is one mode of curriculum delivery. In describing the context, it is first necessary to define and describe PBL.

1.3. Problem-based learning (PBL): a definition and outline of its basic features.

Maudsley (1999) referred to the 'conceptual fog' (p.178) that is PBL, with the term being applied to 'heterogenous educational activities' (*ibid*., p.179). Taylor and Miflin (2008) discussed how the rapid spread of PBL in medical education, coupled with a misunderstanding of Barrows' original conceptualisation of PBL (Barrows & Tamblyn, 1980) and of his references to non-expert tutors (Miflin, 2004), plus differing epistemologies of teachers, demographics of student intake, institutional structures for staff recruitment and training, and so forth, may have led to an enormous variety in what individual schools and even individual teachers mean by PBL.

Barrows and Tamblyn (1980) defined PBL as: ‘the learning that results from the process of working toward the understanding or resolution of a problem’ (p.18). This definition indicates two main features of PBL: the problem and the process. In the medical education context, the problem is an incomplete understanding of a given clinical case and the underlying biology. The clinical case, or scenario, is usually presented in written format, although other modalities include videos (Kamin, O’Sullivan, Deterding & Younger, 2003) or interactive online virtual patients (Poulton, Conradi, Kavia, Round & Hilton, 2009). PBL scenarios represent common clinical cases and are generally written by clinical experts. They are intended to stimulate students’ learning of relevant normal biology and/or relevant pathophysiology, which is the mechanism leading to the specific clinical problems featured in the scenario.

The PBL process is the particular set of steps followed by students as they work together to understand the clinical problem. Variations of the PBL process exist, but the featured medical school uses an adaptation of the University of Maastricht’s 7 Jumps process (Schmidt, 1983; Spencer & Jordan, 1999). Working in small groups of about eight, students:

(1) define any medical terminology or colloquialisms in the scenario and ensure they have a basic understanding of what is going on (for example, it describes the case of a young boy who has fallen off his bike and has cut his hand);
(2) identify learning issues - topics - arising from the scenario (in this example, skin, wound healing, terms used to describe injuries to the skin);
(3) brainstorm their existing knowledge relating to these issues, identify gaps in their understanding, and formulate hypotheses to explain the problem, or how it may be resolved;
(4) generate shared learning objectives/questions that will help them understand/resolve the problem;
(5) identify learning resources to address the objectives;

(6) after a period of independent research and study, and attendance at learning opportunities offered by the medical school, share their new understandings of the clinical problem; and
(7) reflect on the group performance, including the adequacy of their learning and the dynamics of the group interaction.

In the medical school featured in this study, the PBL process takes about two hours; one hour for steps 1 through 5; and a second hour for steps 6 and 7. Between steps 5 and 6, students undertake independent research and study. Step 3, the brainstorm, is considered key, since students recall what they already know about a topic, which gives them a foundation for learning (Norman & Schmidt, 1992; Schmidt, 1983). This is consistent with constructivist learning theories (Murphy, 1997; Savery & Duffy, 1996), which propose that to learn successfully, the individual needs to integrate new knowledge with what was already understood (Van der Vleuten, Dolmans & Scherpbier, 2000; see also 2.2). The content of the brainstorm is recorded by a student scribe, a role which is performed by each group member in rotation. The scribe also records the group's learning objectives. In some models of PBL, individual students or sub-groups take away one learning objective to research and they make a formal presentation of their findings to their peers (Rangachari, 1996). However, in the model employed at the featured medical school, each student must research every one of the learning objectives and the presentation takes the form of a group discussion, where individual members volunteer information and a student chair ensures participation by all. Students take turns at being the chair. To encourage students to come to their next PBL tutorial having learned a manageable amount of material, rather than having produced copious notes that they do not actually understand, during the feedback students are encouraged to speak about a topic without recourse to their notes. They are also encouraged to make use of whiteboards to present diagrams, flow charts and, if they wish, to summarise the discussion.

During PBL tutorials, the students' learning is guided by a facilitator, whose role is to encourage adherence to the PBL process; to ensure a thorough analysis and discussion of the problem; and to encourage students to reflect on their learning (Katz, 1996). Some institutions have experimented with peer facilitation (Micari, Streitwiesser & Light, 2006; Steele, Medder & Turner, 2000), but the medical school in this study has clinical and non-clinical staff members as facilitators. Hogan (2003) suggested facilitator competencies should include active listening, paraphrasing, questioning and summarising. The role is therefore substantially different to the didactic role of staff in many teaching activities typical of more traditional medical curricula: for example, lectures or expert-led tutorials. Nevertheless, facilitators are aware of the learning objectives the medical school intends should arise from each PBL scenario and are expected to use subtle prompting to guide students towards these.

1.4. The professional context: PBL as a pedagogical approach in medical education.

The adoption of PBL as a pedagogical approach in medical education is commonly attributed to faculty at McMaster Medical School, where it was introduced in the 1960s. Aspects of the McMaster model were reportedly evident in curricular reform by medical faculty at Case Western Reserve University, in the late 1950s (Boud & Feletti, 1997). The McMaster model described by Barrows and Tamblyn (1980) is very resource-intensive, and a variation was Harvard Medical School's hybrid model, the New Pathway (Armstrong, 1997). In the 1970s, PBL-based curricula sprang up in other medical schools, including that at the University of Maastricht in the Netherlands and the University of Newcastle, New South Wales. In the UK, the move to PBL-based medical curricula took place in the mid-1990s, when medical schools underwent wholesale curricular change in response to recommendations published in the first edition of the General Medical Council's (GMC's) Tomorrow's Doctors (1993), a curriculum for medical undergraduates. Medical schools were charged with

implementing curricula that had reduced factual content; prepared students for life-long-learning; were student-centred, meaning the focus should be on what students wanted or needed to learn, rather than what teachers wanted to teach; and provided for developing the team-working and communication skills expected of doctors in the modern National Health Service (NHS). A PBL-based approach was one way to address this challenge (Schmidt, 1983; Wood, 2003). Indeed, during the period in which the present study was undertaken, McKendree (2010) noted that 'about 12 of the [then] 32 UK medical schools deliver[ed] PBL programmes' (p.262).

1.5. The specific professional context: The PBL-based curriculum in the featured Scottish medical school.

The particular Scottish medical school featured in this study implemented a PBL-based curriculum in 1996. Prior to this, a development team comprising key clinical and scientific staff and a specially-appointed curriculum development officer spent time in the medical school at the University of Maastricht, whose model of PBL they were to adapt. Back at the home institution, Year Co-ordinators were appointed, responsible for the horizontal integration of the new curriculum, meaning they had to organise teaching within their particular year to ensure that topics coming later in the year built on topics encountered earlier. Theme Leaders were appointed to ensure vertical integration of material from Year 1 to Year 5; that is, they were to ensure that specific themes were encountered in each year of the curriculum, with material in later years building on what had been encountered earlier, and increasing in complexity and/or clinical relevance.

At the time this study was conceived and the data collected, the first two years of the curriculum included eleven PBL blocks over the two-year period, with most blocks being of about five weeks' duration. Since 2011, there has been a substantial revision to the curriculum, with the proportion of PBL cut by about fifty percent, but it nevertheless remains a major mode of curriculum delivery. There has been a concomitant increase in

the number of lectures, post-2011, but otherwise the ILOs and learning opportunities are similar to those pre-2011. Students undertake a student-selected component (SSC) in Year 2, when they choose to study one of a variety of topics offered by faculty. During Years 1 and 2, students also undertake a Vocational Studies component, with weekly small-group sessions in which they learn about ethics, communication skills, evidence-based medicine and other topics of importance to medical practitioners. Students encounter patients from their first year, with timetabled visits to a hospital ward, a general practice surgery and a hospice. Students also learn clinical procedural skills from early in the first year of their curriculum. Finally, they participate in learning opportunities that overlap with the PBL component, including lectures, labs and seminars.

Primarily for reasons of access, this study focuses on PBL in Years 1 and 2 of the curriculum. However, at the time the study was conceived, students also experienced PBL in Year 3, where they were based in hospitals. These PBL sessions were facilitated by hospital-based clinicians and followed a different format to PBL in the earlier years; in Year 3, PBL sessions were more about making differential diagnoses when confronted with clinical problems; that is, deciding which of several possible diagnoses was most likely. In the post-2011 revised curriculum, Year 3 PBL has been replaced by case-based learning (CBL), led by clinical tutors.

From late in Year 3, through Year 4 and much of Year 5, students spend most of their time in hospital-based clinical attachments. They no longer have PBL or CBL. Final exams take place in February, after which students do a 9-week Preparation for Practice course, in which they shadow the Foundation Year 1 (FY1) doctor whose post they will take over.

The curriculum is delivered by a large number of University and NHS staff. In the context of PBL in Years 1 and 2, facilitators are drawn from both groups, but

predominantly the University. There are currently about 200 facilitators on the medical school database. Many staff facilitate one or two PBL groups per annum, but a substantial minority of staff regularly facilitate about six to sixteen PBL groups in a year. Many are highly experienced, having facilitated since 1996. There are also several hourly-paid facilitators, mainly but not wholly comprised of retired faculty who wish to continue their involvement with the curriculum; they may also be highly experienced in PBL facilitation. Thus there are three main categories of PBL facilitator in Years 1 and 2: university-based faculty who are usually scientists, NHS-based clinical faculty, and hourly-paid staff. Facilitators from each category feature in the present study.

1.6. Positioning myself within the study.

At this point, it is pertinent to explain my own role in the curriculum and medical school featured in this investigation. I am by background a biomedical scientist who conducted bench research in the field of breast cancer. I was employed in institutions and departments where biomedical scientists and clinicians worked in close collaboration. In 1993, I joined the medical faculty of the institution where this study took place. I gradually became involved in undergraduate medical education and at the outset of the study I was Deputy Co-ordinator for Year 1. In 2009 I became Co-ordinator, subsequently called Director, for Year 1. In 2013, I became Deputy Head of the School, with a pre-clinical remit. I am a member of the School's Senior Management Group.

I have facilitated PBL since the post-1996 curriculum came into being, at one point facilitating as many as 18 groups per annum, but more recently about 4 or 5 groups per annum. Since 2006, I have run the training programme for PBL Facilitators in Years 1 and 2. I have also at various times delivered lectures, labs, seminars and SSC teaching to students in Years 1 and 2, as well as providing lectures and lab projects for students taking an intercalated BSc degree between the 3rd and 4th year of their medical degree. However, I am most closely identified with the PBL component of the curriculum and I

am very much drawn to the facilitative style of teaching. I first became involved with the PBL-based curriculum as a consequence of the enthusiasm shown by the then curriculum development officer, who was very positive about the benefits of PBL methodology relative to a traditional medical curriculum. However, experience and acquaintance with the literature have shown that the evidence for these benefits is less clear than once imagined.

1.7. The professional issue.

This chapter has described the pedagogy of PBL, and also how the PBL process is conducted at the featured medical school. It describes my personal commitment to PBL. I had been carried along on a wave of enthusiasm when the PBL-based curriculum was introduced in 1996 because (i) as an undergraduate, I had had negative experiences of didactic teaching, which is the basis of the traditional medical curriculum as well the biomedical science curriculum to which I was exposed; (ii) in contrast, PBL seemed an exciting way for students to learn; and (iii) as a non-clinician, the move to a PBL-based curriculum afforded me greater opportunities for involvement than would have been the case with the traditional medical curriculum. I attended training and staff development sessions but, in hindsight, I didn't engage critically with the literature, happy to assume the curriculum developers knew what they were talking about, which is ironic, given the subject of this thesis.

In the featured medical school, there was incremental erosion of the principles underpinning the PBL-based curriculum: for example, a move to release faculty's intended objectives more frequently; a move to make attendance at supporting labs compulsory; and the introduction of a week of foundation lectures in one of the Year 2 PBL Blocks. The negative trends were paralleled in other PBL-based curricula (Moust, Van Berkel & Schmidt, 2005). Simultaneously, I was increasingly aware of negative opinion from some clinical colleagues within the local NHS community and beyond. I

began to look more carefully for primary literature that supported PBL. This was disquieting, since I came to realise that although relevant literature did exist, it was equivocal in its support for PBL. Also, much of the literature was difficult to access because of my lack of familiarity with the qualitative research paradigm.

The specific professional issue that led to the research contained in this thesis was my realisation that one of the claimed ILOs for PBL is the promotion of critical thinking by students (Maudsley & Strivens, 2000a, 2000b), yet at the time this study was conceived, there was relatively little direct evidence for this in the medical education literature. In addition, the theoretical basis was lacking in studies of critical thinking in PBL, or was not made explicit. There were and still are very few studies that help us understand which aspects of a PBL-based curriculum promote critical thinking, if any. Aside from my personal - vested - interest in practising and advocating a method of teaching and learning that is evidence-based and meets its claimed ILOs, the lack of evidence that PBL promotes critical thinking was important precisely because critical thinking is held to underpin clinical reasoning, clinical judgement and decision-making; key professional skills for clinicians (see Chapter 4). Thus, I commenced this study with twin goals: to form a personal conceptual framework of critical thinking; and to design and conduct empirical research that would demonstrate, or otherwise, whether critical thinking was evident in the PBL context. Furthermore, I wished to gain insight into which specific features of the PBL tutorial could enable or impede critical thinking.

Prior to describing the research study, there follows a literature review that begins by critiquing the extent to which PBL meets various ILOs. Before addressing the ILO of critical thinking, the literature on critical thinking is itself reviewed and various conceptualisations are critiqued for their relevance to medicine, medical education, and to PBL. Evidence that PBL promotes critical thinking is then critiqued. Finally, aims and research questions are formulated to guide empirical research.

Chapter 2. Critical review of empirical research on some intended learning outcomes (ILOs) for PBL.

For the sake of clarity, the critical literature review has been split into three chapters. This chapter provides a critical review of empirical research that addresses the extent to which PBL does or does not meet various intended learning outcomes (ILOs) claimed for it.

2.1. Intended Learning Outcomes of PBL.

In recent years there has been controversy over the effectiveness of PBL as a learning and teaching methodology (Albanese, 2000; Colliver, 2000, 2002; Dolmans, 2003; Farrow & Norman, 2003; McKendree, 2012; Newman, 2003; Newman, Van den Bossche, Gijbels, McKendree, Roberts, Rolfe, Smucny & De Virgilio, 2004). Although there has recently been concern that newly-qualified Foundation Year (FY1) doctors may not be adequately prepared for work on the wards (Matheson & Matheson, 2009), there is little evidence to suggest that students from PBL-based curricula are any less prepared than those from traditional curricula. Indeed, in a multi-method, prospective, cross-sectional study commissioned by the General Medical Council (GMC), which compared the perceptions and competencies of students from a PBL-based, a traditional and a graduate-entry medical school, the authors found little difference between graduates from the different schools, in terms of their overall preparedness for practice (Illing, Morrow, Kergon, Burford, Spencer, Peile, Davies, Baldauf, Allen, Johnson, Morrison, Donaldson, Whitelaw & Field, 2008).

Nevertheless, at a 2009 workshop featuring presentations by faculty from several UK medical schools with PBL-based curricula (McKendree, 2010), a common theme was dealing with the perception that PBL is not evidence-based. Taylor and Miflin (2008)

argued that this perception has arisen in part because of the huge variation in what educators understand by the term PBL, and in how PBL is practised in various medical schools, which makes it difficult to generalise findings. Other explanations include the fact that many studies have examined PBL curricula as a whole, rather than considering specific aspects of those curricula; the multiple ILOs proposed for PBL; and different conceptions of what constitutes evidence. McKendree (2012) recently advocated that the medical education community should take a wider perspective on evidence when evaluating the effect of PBL.

2.2. The effect of PBL on knowledge acquisition and application.

Until the mid-1980s, the literature on PBL was descriptive, rather than evaluative (Boud & Feletti, 1997). Schmidt (1983) identified the need for empirical research in this area. Many researchers (Antepohl & Herzig, 1999; Antepohl, Domeij, Forsberg & Ludvissson, 2003; Beachey, 2007; Distlehorst & Robbs, 1998; Dochy, Segers, Van den Bossche & Gijbels, 2003; Herzig, Linke, Marxen, Borner & Antepohl, 2003; Hmelo, 1998; Kaufman & Mann, 1998) concerned themselves with whether PBL meets the ILO of knowledge acquisition, or its application. The broad conclusion from such studies was that students from PBL-based curricula may do slightly less well than traditionally-taught students in standard written exams that come at the end of medical school; but PBL graduates retain knowledge and seem better at application of knowledge in tests of clinical reasoning ability (Dochy *et al*, 2003). Before looking in detail at these studies, it is worth considering a conceptual issue: the nature of knowledge.

2.2.1. Knowledge.

A major issue with research into the effect of PBL on knowledge acquisition is the epistemological stance of the researchers. Epistemology is the theory and logical analysis of knowledge (Scheffler, 1999). Rationalists, such as mathematicians, believe knowledge is wholly objective and view the mind as a ‘deep well of necessary truths …

[that] … may be established by deductive chains linking them with self-evident basic truths' (*ibid*., pp.2-4). On the other hand, the empiricist tradition is aligned to the natural sciences and its proponents are generally positivists, who believe knowledge is external to the individual and may be discovered and verified only by empirical means. Realists also believe in the existence of an independent, external world, but acknowledge it may not be possible to verify every aspect of that world (Muijs, 2004; Smith, 2006). However, interpretivists view knowledge as subjective, reflecting personal experiences and values: they recognise the possibility of multiple perspectives or versions of the truth. Finally, a constructivist epistemology (Murphy, 1997) is one in which the individual believes that knowledge is constructed by the knower (Kitchner & King, 1981). It is unlikely that any two constructions will be the same, given our varied learning and experiences (Van der Vleuten *et al*, 2000). The constructivist epistemology recognises knowledge as liable to continuous modification:

> … acquiring knowledge is more than consuming information. To understand the information, students need to structure, organise, and restructure information.
>
> (Van der Vleuten *et al*, 2000, p.247)

These authors note that 'in traditional [medical] curricula the emphasis is on knowledge transfer from teacher to student and is based on a conception where 'knowledge is … the sum of information to which the student has been exposed' (*ibid*.). In traditional medical curricula, an empiricist or realist epistemology is assumed; whereas PBL-based curricula are consistent with a constructivist epistemology (Murphy, 1997; Savery & Duffy, 1996). Generally, researchers in medical education do not make explicit their epistemological stance, but it is likely, given their clinical or biomedical background, or implicit in their writing, that many are empiricists or realists.

2.2.2. Outcome measures in quantitative studies.

The outcome measure in many studies on the effectiveness of PBL on knowledge acquisition is students' performance in high-stakes written exams, which risk emphasising factual recall. These may not be a fair means of testing the effectiveness of PBL (Van der Vleuten *et al*, 2000), but regardless of whether such exams are constructively aligned (Biggs, 1996) with PBL methodology, they are precisely the type of exams that must be passed for entry into the profession in most countries. This is especially true in the U.S.A., where all students must pass the United States Medical Licensing Examination (USMLE); moreover, there is a body of opinion that the UK should have a similar national exam, or at least common questions in the final exams sat in different medical schools. Currently, all prospective medical graduates in the UK participate in a national situational judgment test, which comprises single-best-answer (SBA) questions, and which contributes to selection into postgraduate Foundation Programmes. This does not take into account the style of curriculum that students have experienced; the same is true for specialist postgraduate exams, which are administered at a national level. Therefore, the outcome measure of performance in high-stakes written exams is arguably a reasonable measure of the effectiveness of PBL in promoting the acquisition and application of knowledge, since all curricula, PBL-based or traditional, need to prepare their students to pass such exams.

In comparing the performance of students from different curricula, often authors are interested in determining the effect size of PBL versus traditional curricula. Put simply, effect size is a measure of the difference between two groups in response to some intervention. An effect size of 1 would mean that the intervention was exactly as effective as the control. According to Distlehorst and Robbs (1998), 'a strong effect size is equal to 0.80, a moderate effect size is 0.50, and a weak effect size is at 0.25' (p.134). With this in mind, they were only able to demonstrate an effect size of 0.18, a weak advantage for PBL, with regard to students' subsequent performance in the USMLE.

In his review of studies on the effectiveness of PBL, and citing Bloom, who found an effect size of 2 for one-to-one tutoring, Colliver (2000) proposed it would be reasonable to expect an effect size of 1 for PBL, since he expected it would be less effective than one-to-one tutoring. He did not offer any rationale for this, but it may reflect an expectation that the staff-to-student ratio in one-to-one tutoring is advantageous, since the tutor's whole attention is on the single student. Colliver (2000) argued that for a 'major curricular intervention' (p.261) such as PBL, one would expect an effect size in the range of 0.8-1.0, and concluded there was 'no convincing evidence that PBL improves knowledge base' (*ibid*., p.259). Albanese (2000) pointed out that application of such stringent criteria would have led to the dismissal of 'over half the psychological, educational and behavioural treatment literature and a number of drug therapies in common use' (p.729). However, Colliver (2000) qualified his conclusion about the effectiveness of PBL, saying there was insufficient evidence of advantage, given the resources required. It seems reasonable to argue that the resource-intensive nature of PBL means it ought to offer substantial benefits over the *status quo*. There is another reason to set relatively rigorous standards for measuring the effectiveness of PBL on knowledge acquisition: the possible dual advantage of input from the facilitator and from peers. On this basis, one could argue that PBL should have a greater effect size than tutoring, that is, >2.

Nevertheless, Colliver's stance may be criticised because he applied his chosen barometer inconsistently. Reviewing Hmelo's (1998) study of the effect of PBL on students' reasoning about clinical cases, the number of clinical findings accounted for, and the use of scientific concepts in their explanations, Colliver (2000) computed effect sizes of 2.36, 1.45 and 1.99, respectively. Yet he was dismissive of these findings, saying PBL students were practised in such tasks, whereas traditional students were not. Yet it is at least as reasonable to measure traditionally-taught medical students' ability in tests of clinical reasoning as it is to measure PBL-taught students' ability in high-stakes written exams. Moreover, Hmelo (1998) used outcome measures that were particularly relevant to her participants' future role as clinicians, requiring application of knowledge

and focussing on activities that might generally be regarded as requiring a greater degree of understanding, as opposed to straightforward factual recall. This is consistent with claims that PBL promotes deep understanding of learned material (Hmelo-Silver, 2004; Woods, 2003). Furthermore, by comparing students who participated in PBL full-time versus those who did it for just part of the time, as an elective, Hmelo (1998) was able to demonstrate that intensity of exposure to PBL was related to performance in the outcome measures employed, strengthening her conclusion that PBL was effective in promoting application of knowledge.

One possible confounding factor in comparisons of traditional versus PBL-based curricula is the potentially self-selecting nature of students opting for the latter. Antepohl and Herzig (1999) addressed this using a randomised, controlled trial (RCT) study design. Students were randomly-assigned to concurrent pharmacology courses, one lecture-based and one PBL-based. Both groups fared equally well in multiple-choice questions (MCQs) and short note questions. The best that may be concluded from this study is that the PBL students were not disadvantaged relative to traditionally-taught students, in terms of knowledge acquisition.

In a pilot systematic review on behalf of the Campbell Collaboration Systematic Review Group, Newman (2003) and his fellow reviewers concluded there was a lack of evidence for the effectiveness of PBL. With inclusion limited to (quasi-)experimental studies with 'objective measurement of student performance/behaviour' (*ibid.*, p.16), of ninety-one citations from five previous literature reviews on the efficacy of PBL, all but fifteen were excluded from further study; and of these, only twelve contained data considered extractable for meta-analysis (Farrow & Norman, 2003). These twelve studies showed effect sizes for accumulation [*sic*] of knowledge that ranged from -4.9, meaning very strongly in favour of the traditionally-taught control group, to +2.0, meaning strongly in favour of the PBL group. The mean effect size from the meta-analysis of all twelve studies was -0.3, interpreted as a weak effect in favour of the traditionally-taught control group, although Newman (2003) noted that the 95% confidence intervals, a measure of

the certainty of the result, were such that an actual weak overall effect in favour of PBL could not be ruled out. He later commented that the mean effect size should be treated with caution as the outcomes included were not independent (Newman, 2005). Limitations of Newman's (2003) report include that the researchers did not go to the primary literature to identify articles for review, so they potentially missed key papers that met their inclusion criteria. The justification may have been that the review was intended to be a pilot, but it seems no full systematic review using the same criteria has since been undertaken, yet the Newman pilot has been considered by some as definitive evidence that PBL does not work, although Newman (2005) himself acknowledged the study was not comprehensive.

Newman's (2003) original research questions were wide-ranging and related to several proposed ILOs for PBL, yet the studies included in his meta-analysis focused almost exclusively 'on reporting outcomes from tests or assignments that [were] arguably … measuring the accumulation of knowledge and in particular the use of multiple choice formats' (*ibid*., p.28), which he attributed to the inclusion of only 'high quality studies' (*ibid*.). In fact, it seems that Newman found exactly what might have been predicted. The restrictive inclusion criteria he employed would almost certainly exclude studies on several highly-desirable ILOs of PBL; for example, enhanced communication skills.

2.2.3. Qualitative studies in PBL research.

In reacting to Newman's report, Dolmans (2003) objected to the inference that (quasi-) experimental studies were the only legitimate means of researching PBL. She argued that by taking a narrow view of what constitutes legitimate educational research, Newman had excluded a large body of relevant literature. Newman (2003) did not discuss the legitimacy of his approach, simply stating that studies which 'utilize[d] solely qualitative approaches …[would]… not be included in the review' (p.16). The implication is that he did not think this an issue worthy of further comment, since he did discuss other limitations in his report.

The exclusion of qualitative studies and the failure to address this as a limitation is seen in other systematic reviews, such as one by Koh, Khoo, Wong and Koh (2008), on the impact of PBL on physician competencies. The exclusion of qualitative studies may stem from a perception that it is difficult to appraise the quality of such research. However, just as there are indicators of quality in quantitative research, so too are there criteria for good qualitative research. For example, in their systematic review of the utilisation of PBL for teaching in the clinical setting, Williams and Beattie (2008) employed The Joanna Briggs Institute Qualitative Assessment and Review Instrument (QARI; Pearson, 2004), which asks for judgments about, for example, the congruity between the research methodology and the research questions. Williams and Beattie (2008) identified five qualitative studies that met their inclusion criteria, and of these, four met nine out of ten QARI criteria (Adejumo & Ganga-Limando, 2000; Dornan, Hadfield, Brown, Boshuizen & Scherpbier, 2005a; Dornan, Scherpbier, King & Boshuizan, 2005b; and O'Neill, Willis & Jones, 2002). Overall, Williams and Beattie (2008) concluded that PBL methodology did not transfer well to clinical settings, for reasons that included clinical teachers' inadequate understanding of the principles of PBL; and the absence of peer learners, such as are found in a PBL group.

Alternatively, the exclusion of qualitative studies from a systematic review may reflect that the paradigm is not held in such high esteem by the researchers. Farrow and Norman (2003) suggested that using RCTs and quasi-experimental approaches to answer research questions in medical education may resonate with a community that 'has seen the success of RCTs in biomedical science' (p.1132), but educational interventions are complex and their evaluation often requires a different approach. The crux of the matter is whether the chosen study design is best-placed to answer the research questions.

In fact, Newman *et al* (2004) argued that systematic review of (quasi-)experimental research was consistent with the practice of the Cochrane Collaboration (http://www.cochrane.org/), which conducts systematic reviews to inform clinical

decision-making in healthcare, and was the most appropriate methodology given the group's purpose: namely, to compare the effectiveness of PBL-based and traditional curricula. They were looking for cause-and-effect relationships and argued that 'the experiment is a particularly efficacious design for causal inference' (Newman, 2003, p.15). This is true. However, experimental designs ideally require that only a single variable differs between the test and control groups, which did not apply in comparisons of PBL-based and traditional medical curricula.

Thus, to summarise, studies investigating the effect of PBL curricula on the ability to recall and apply knowledge are equivocal and may reflect the specific outcome measure employed and the use of study designs that are not best-suited to the purpose. If anything, PBL may enhance application of knowledge in clinical contexts.

There are ILOs for PBL over and above knowledge acquisition or application. These include a capacity for self-directed learning; team-working ability; and communication skills. Yet again, the existing research has limitations. The remaining sections of this chapter say a little about such evidence as exists.

2.3. The effect of PBL on self-directed learning.

Self-directed learning (SDL) has been defined as 'the ability to learn on one's own' (Knowles, 1975, p.17). In the PBL context, Schmidt (2000) suggested SDL is 'the preparedness of a student to engage in learning activities defined by himself rather than a teacher' (p.243). Whilst this incorporates the ability to identify gaps in one's understanding of a situation, plus motivational aspects of SDL, and learner autonomy, it omits the regulatory aspect of SDL evident in other definitions. According to Garrison (1992), 'what appears to be common to most conceptualisations of SDL is the notion of some personal control over either or both the planning (goals) and management (support) of the learning experience' (p.240). He subsequently proposed a model for SDL that included motivation, self-monitoring and self-management. Whereas self-

management is associated with external factors related to the learning process, such as management of learning resources and otherwise influencing the context for learning, self-monitoring instead has to do with the mental activities whereby the learner takes responsibility for constructing meaning: cognition and meta-cognition, the latter which has been referred to as thinking about thinking (see 3.3.1). Garrison (1992, 1997) recognised links between the self-monitoring aspect of SDL, and critical thinking; this will be revisited in Chapter 3.

In addition to the literature on SDL, there exists one on self-regulated learning (SRL), defined as 'the process by which students engage in different strategies to regulate their cognition, motivation/affect, behaviour, and the context' (Rhee & Pintrich, 2004, p.31). Examples of activities relevant to these four aspects of SRL include some that might reasonably be expected to be developed through PBL:

- organisational strategies to regulate cognition include making outlines, concept maps and diagrams, which may be employed by PBL students during their individual research, or during the brainstorm or debrief steps of the PBL process;
- enhancing interest to regulate motivation may be achieved via the clinically-relevant nature of the scenarios, or through role-play, as students take the part of different characters when reading a PBL scenario;
- time management to regulate behaviour could be developed through working through the PBL process in the allotted time, or by reflection on time spent on individual research; whilst
- help-seeking behaviour to control the context for learning could include asking peers for explanations or validation of information brought to PBL.

Although there seems to be substantial overlap between SDL and SRL, the major contributors to the two fields differ; and SDL and SRL are not synonyms. Archer (2004) distinguished between partial and full SRL, where only the latter requires that the student identifies or sets the learning task. Thus only full SRL as defined by Archer

equates to SDL. Consistent with this, Loyens, Magda and Rikers (2008) suggested that SDL encompasses SRL, but not vice versa. Garrison's (1997) concept of self-management seems consistent with (partial) self-regulation, which he himself acknowledged. To summarise, self-directed learning is a comprehensive activity that encompasses setting the goals for learning, managing external factors to maximise learning, and employing the necessary intellectual skills to ensure that learning is actually achieved. Managing external factors is termed self-management, or self-regulated learning, which is just one component of self-directed learning.

Schmidt (2000) critiqued some assumptions made about SDL in a PBL context. He pointed out that students do not really have the freedom to learn whatever they deem appropriate; there are varying degrees of guidance and influence from peers, the facilitator, curriculum designers and the programme assessment. Students also have limited study time to pursue topics of interest. Within the context of scenarios and learning opportunities provided by faculty, students may identify and pursue personal learning issues, but if the facilitator encourages students to set objectives that are of interest to them, but not intended by faculty, this may lead to student dissatisfaction, and the perception that they are learning inappropriate material. A degree of maturity may be required for the learner to identify and pursue individual learning needs in parallel with the learning expected by faculty. Miflin, Campbell and Price (2000) suggested the medical education community had misunderstood the relationship between PBL and SDL. They clarified that fostering SDL is not about leaving students to cope on their own, but requires 'progressive development of student responsibility for learning and gradual reduction of the direction provided by faculty' (p.306). To summarise, whilst PBL theoretically facilitates the development of SDL, in reality, true self-direction is subject to the constraints outlined above, but PBL can potentially allow students to develop at least the self-regulatory aspects of SDL.

Empirical studies tend to confirm that students in PBL-based curricula show behaviours considered as proxy for self-regulatory aspects of SDL, such as library use (Blumberg &

Michael, 1992); and that PBL students who spend more time on study fare better in assessments (Van den Hurk, 2006). Hill, Rolfe, Pearson and Heathcote (1998) surveyed recent graduates from three medical schools in New South Wales, including one with a PBL-based curriculum. One of the findings was that PBL graduates were significantly more likely than graduates of traditional schools to feel prepared for SDL. However, the findings were limited by a response bias in favour of the PBL graduates and by the self-reporting nature of the study. Moreover, Hill *et al* (1998) used descriptive and inferential statistics inappropriate for the analysis of Likert-derived ordinal data (Jamieson, 2004), thereby weakening the credibility of their findings.

Blumberg and Michael (1992) also used inappropriate statistical analysis of Likert-type data, but triangulated their findings by comparing students' self-reporting on frequency of library visits against library circulation data. They found that students on a PBL-based medical curriculum were more likely to consult library resources than were students on a traditional curriculum, and they were more likely to use primary literature and reference books. In their particular PBL curriculum, course content was defined by a combination of student- and faculty-generated learning objectives. Blumberg and Michael (1992) noted that provision of some faculty-generated objectives did not seem to impact negatively on SDL by students, but it may be more accurate to say that faculty-generated objectives did not impact negatively on the SRL aspects of SDL.

In a quasi-experimental study with nursing students in a hybrid PBL curriculum, Williams (2004) administered the Self-Directed Learning Readiness Scale (SDRLS) questionnaire at either end of the year. She found no difference in students' self-reported readiness for SDL, but this conflicted with thematic analysis of focus group data, which showed students were developing characteristics associated with SDL - or more accurately, SRL - such as control over the resources used, and a sense of responsibility for their group's success. Possibly, inappropriate statistical analysis of survey data could account for the conflict in the quantitative and qualitative data, or it may be, as Williams

(2004) suggested, that students in the hybrid curriculum received mixed messages which led to confused perspectives on SDL.

In summary, there is much theorising about the promotion of SRL or SDL by PBL-based medical curricula, but there is relatively little in the way of empirical evidence, and this focuses on what Garrison (1997) termed self-management of resources for learning, including time.

2.4. The effect of PBL on team-working and communication skills.

In their systematic review, whilst only fifteen articles were included from 102 initially identified, Koh *et al* (2008) concluded there was moderate or strong evidence that graduates of PBL-based curricula were better able to cope with uncertainty, to appreciate legal and ethical aspects of healthcare, and to communicate effectively. A common limitation of studies looking at such soft skills is that they rely on self-reporting by participants. The GMC-commissioned study (Illing *et al*, 2008) with graduates of one PBL-based, one traditional, and one graduate-entry medical school minimised the effect of self-reporting by using data collected at 0, 4 and 12 months post-graduation; and by triangulating with data from undergraduate tutors, educational supervisors, key managers, and members of the multi-professional teams who worked with the new graduates. There was little difference between graduates from the different schools. There was a suggestion that PBL graduates might be 'better information gatherers' (*ibid*., p.204), although respondents may have been influenced by the reputation of the relevant medical school. Students from all three schools were underprepared for some aspects of their new work environment: they were unused to performing clinical skills in an environment where they had multiple demands on their time, needed to prioritise, and had to deal with acute cases; they initially lacked knowledge on ethical and legal issues; and students from all curricula were significantly underprepared for prescribing. Whilst they all had good communication skills, they had difficulty in 'complex communication tasks' (*ibid*., p.219), such as dealing with angry

relatives, although there was a perception that maturity helped. Overall, this study showed that a PBL-based curriculum was as effective as a traditional, or a graduate-entry curriculum, at least with the outcome measures used.

To conclude, this Chapter has looked in some detail at the literature on certain ILOs claimed for PBL. One particular ILO attributed to PBL is that it promotes critical thinking by students (Maudsley & Strivens, 2000a, 2000b). Before going on to consider the evidence, it is appropriate to have a clear conceptualisation of critical thinking, which is addressed in the following Chapter.

Chapter 3. Critical review of literature on critical thinking and development of a conceptual framework.

Before examining various definitions and conceptualisations of critical thinking, it is worth defining some terms.

3.1. Defining thinking and criticality.

One of the most influential writers on thinking was John Dewey, who wrote his seminal work, How We Think, in 1910, reprinted in 2009; plus a substantial 'restatement' (Dewey, 1933, p.iii) of this text. He said it is difficult to define thinking and thought, the product of thinking, because 'everything that comes to mind, that goes through our heads, is called a thought' (Dewey, 2009, p.1). Lipman (1989) defined thinking as: 'the conscious processing of experience' (p.5). Experience could mean anything to which the individual is subjected, be that a sensation, the external environment, or the thoughts of others; conscious implies awareness of this experience as it is happening, or retrospectively; whilst processing implies thinking that is active and deliberate. Lipman's definition seems appropriate for our purpose, since we are interested in the thinking that occurs in an educational setting.

Many types of thinking may be identified, including critical thinking. De Bono (2005) noted the word critical derives 'from the Greek word *kritikos* which means judge' (p.15). Garrison (1992) expanded on this: '[to be] critical means to judge and not to take things for granted' (p.138). Thus we can make a preliminary definition of critical thinking as a cognitive activity whereby analysis and assessment of the matter at hand allows us to make judgments. As shall become clear, this definition might resonate with some proponents of critical thinking, but it omits important aspects.

3.2. Types of thought.

Many writers on thinking and critical thinking have been influenced by John Dewey, including Garrison, whose conceptualisations of critical thinking have been particularly influential in this study (see 3.3). Dewey (1933, 2009) identified specific types of thought, which he presented in an apparently hierarchical fashion: abstract thought, belief, and reflective thought.

Abstract thought generally relates to things not directly experienced and may require the thinker to make 'analogical extensions' (Boroditsky & Ramscar, 2002) from experienced events. This would seem to be quite sophisticated, yet Dewey (1933) regarded abstract thought as lower-order thinking, saying it lacked 'controlling purpose and end' (p.8). Dewey was concerned primarily with purposeful thinking that enabled the thinker to draw conclusions and thereby anticipate and exercise some control over his future circumstances. He may have presented abstract thought as relatively unsophisticated because the resulting knowledge, the idea produced, was not necessarily verifiable by empirical methods, and Dewey was writing at a time when the dominant discourse was positivism and the scientific method, whose proponents held empirical verification as the test of true knowledge (see 2.2).

Belief, as Dewey (2009) defined it, is synonymous with conclusion, a type of thought based on supporting statements, termed grounds, or reasons. However, the thinker has played no active part in reaching or framing the thought (Dewey, 1933). Beliefs are effectively 'prejudices … not conclusions reached as the result of personal mental activity, such as observing, collecting, and examining evidence.' (*ibid*., p.7). Again, we see Dewey influenced by the dominant discourse, the scientific method. An individual may adhere to specific beliefs because they are espoused by those in authority, or they are to his advantage, or they are consistent with something about which he feels passionately. Beliefs may be a consequence of what Paul (1995) defined as weak-sense critical thinking (see section 3.3.3).

Conversely, in reflective thought the reasons for conclusions are examined by the thinker (Dewey, 1933). This comes close to Missimer's (1995) definition of critical thinking as 'the consideration of alternative arguments in light of their evidence' (p.108), arguments being conclusions plus their supporting reasons (Browne & Keeley, 2007). Dewey (1933) added that reflective thinkers also consider the logical consequences of a conclusion. The example he gave was Christopher Columbus' conclusion that the world was round, which - if true - had implications for navigation. Dewey (1933) suggested that reflective thinking involves a state of uncertainty, followed by cognitive activity directed towards resolving the conflict. He described this conflict-resolving activity as having five stages:

1. initial suggestions for possible solutions;
2. intellectualisation of the uncertainty/dissonance into a problem to be solved;
3. review of possible solutions and gathering evidence in support of these;
4. 'reasoning' (Dewey, 1933, p.111), or as Garrison (1991, 1992) expresses it, mental elaboration of the conclusion; and
5. testing of the favoured hypothesis by 'experimental corroboration, or verification' (Dewey, 1933, p.113).

Garrison (1991, 1992) initially used Dewey's notion of reflective thinking synonymously with critical thinking but, as we shall see, he and others (Brookfield, 1987; Lipman, 1989, 1991, 1995) had broader perspectives on how the critical thinker's conclusions might be tested. In the next sections, various definitions and conceptualisations of critical thinking are explored in more detail.

3.3. Definitions and conceptualisations of critical thinking.

We earlier defined critical thinking as a cognitive activity whereby analysis and assessment of the matter at hand allows one to make judgements (see 3.1). If one had to define critical thinking as briefly as possible, then judgmental thinking might come

close, because making judgments is either contained within, or the logical consequence of, other definitions. For example, Browne and Keeley (2007) suggested that critical thinking involves asking critical questions, by which they meant questions that, when answered, allow one to make judgements. However, as we shall see, to focus on judgment is to ignore other facets of critical thinking (Brookfield, 1987; Garrison, 1991, 1992; Lipman, 1995).

Unfortunately, the words critical and judgment have negative connotations, expressed by Mingers (2000), who noted that 'in everyday language, being critical means finding fault and being negative about something' (p.225). Such negative connotations led De Bono (1985) to reject critical thinking as a worthwhile intellectual activity. Writing from a business perspective, he regarded critical thinking as confrontational and not conducive to solving business problems constructively. However, his multi-perspective alternative of 'parallel thinking' (De Bono, 1985, p.1) was not so far removed from Paul's (1995) conceptualisation of strong-sense critical thinking (see 3.3.3). Siegel (1990) cited McPeck as saying critical thinking was characterised by a 'certain scepticism' (p.77), which could also be equated with negativity. However, Garrison (1991) pointed out that 'scepticism implies not taking things for granted but … allowing for alternative possibilities' (p.289). Viewed in this way, scepticism is not a negative attribute, but indicates openness to the possibility of alternative explanations for our experiences. Consistent with this, Brookfield (1987) incorporated into his definition of critical thinking the ideas of 'identifying and challenging assumptions' (p.15), but also 'exploring and imagining alternatives' (*ibid*.). Thus critical thinking may be conceptualised as not taking things for granted, but also being receptive to, or actively seeking, alternative explanations for what we experience. There follows a more detailed consideration of various conceptualisations of critical thinking, and the extent to which they may or may not be relevant to medicine as a profession, to medical education, and in particular, to learning within PBL tutorials.

3.3.1. Application of a set of aligned cognitive activities.

Critical thinking may be conceptualised as performing aligned cognitive activities such as questioning, reasoning, evaluating arguments, making judgements, and reflecting on one's thinking.

Questioning.

Garrison (1991) defined critical thinkers as sceptical in the sense of 'not taking things for granted' (p.289). Inherent scepticism will lead critical thinkers to ask questions about such things as the credibility of a source of information, or the evidence for a claim. Accordingly, many definitions of critical thinking (Browne & Keeley, 2007; Fisher, 2006) include some element of questioning. These questions may be indicated by the use of simple adverbs, such as *how* or *why*. Da Silva and Dennick (2010) used such adverbs as indicators of critical thinking in their corpus linguistics analysis of discourse during PBL tutorials in an English medical curriculum (see 4.3.4). Questioners who use these words may be seeking information (what signs and symptoms would you expect to see?), seeking explanations (how does the body constantly replenish red blood cells?), or seeking justification (why do you think that treatment should be offered in this instance?). These could equally be questions asked of a medical student by a clinical teacher, or of a junior doctor by his senior colleague, whilst one might expect that self-questioning along similar lines would be part-and-parcel of critical thinking about diagnosis and management.

To stimulate critical thinking, Paul and Elder (2006a) advocated Socratic questioning, which Paul (1995) defined as 'a mode of questioning that deeply probes the meaning, justification, or logical strength of a claim, position or line of reasoning' (p.550). It is not obvious there would be a role for Socratic questioning in the clinical environment, but it might be useful in the education of medical students. There is scope for this kind

of questioning in a PBL tutorial (De Grave, Dolmans & Van der Vleuten, 1999), especially with scenarios featuring end-of-life decisions or other ethical dilemmas.

Browne and Keeley (2007) advocated the use of critical questions such as 'what is the evidence?' (p.2), whilst Meltzhoff (2004) devised an alternative set of critical questions that have been used at practitioner level to develop the critical thinking and critical appraisal skills of Masters' students on a biomedical programme (Jamieson, 2008). However, Meltzhoff's (2004) critical questions would likely have limited use in PBL tutorials, since they were concerned with analysing and evaluating empirical data, which is seldom a focus of PBL tutorials in the featured curriculum.

Reasoning.

Another cognitive activity associated with critical thinking is reasoning (Fisher, 2006), defined by Paul (1995) as making clear the mental steps by which one arrives at a conclusion. Reasoning may be deductive or inductive, and both are relevant to the practice of medicine. Deductive reasoning moves from the general to the specific. The soundness of deductive reasoning is based on whether the structure of the argument is valid, and whether the reasons, or premises, given in support of the conclusion are true. If so, provided any assumptions are valid, then the conclusion will be true (Bowell & Kemp, 2005). An assumption is defined as a reason that is not made explicit; it may lead to inferences, which are implicit conclusions. An ability to identify underlying assumptions is a feature of deductive reasoning (Wasim, 2007). A clinically-relevant example of deductive reasoning would be that if an elderly person developed shingles, the doctor might conclude that the patient had previously been infected with the chickenpox virus, *Varicella zoster*. Shingles is a manifestation of latent chickenpox virus, which is stimulated to replicate after years of hiding in the patient's nervous system. The validity of the doctor's conclusion would depend on there being no other mechanism to contract shingles.

In inductive reasoning, one cannot be certain of the truth of the premises - for example, that the sample is representative - but one may nevertheless judge the probability that the conclusion is true. A clinically-relevant example would be where a new drug is tested on 1,000 patients and elicits a therapeutic response in 67% of patients. Scientists might conclude that the drug will likely be efficacious in 67% of cases in the population. The confidence they may have in this conclusion depends on the size of the sample relative to the population; and whether the sample was a good representation of that population with regard to sex, age distribution and ethnicity. For inductive reasoning in clinical medicine, statistical constructs such as confidence intervals and other measures of certainty are relied upon, to guide judgment.

There is a substantial literature on clinical reasoning, which is reasoning in a clinical environment. In the interests of space, and because reasoning is only one aspect of one conceptualisation of critical thinking, in this thesis only limited attention is given to this literature. Clinical reasoning is traditionally applied in the context of making a diagnosis (Charlin, Tardif & Boshuizen, 2000). Expert doctors engaged in clinical reasoning were formerly thought to employ the hypothetico-deductive model (Eva, 2004), which involves generating multiple, competing hypotheses then collecting data - a history and clinical tests - to confirm or refute each hypothesis. If necessary, a new set of hypotheses is created, in an iterative cycle of hypothesis generation and testing (Charlin *et al*, 2000), until a diagnosis is reached. However, it is now recognised that experts use different mechanisms for clinical reasoning (Eva, 2004), depending on their experience, recent encounters with similar problems, and so on. Often, expert doctors will immediately recognise specific 'illness scripts' (Charlin, Boshuizen, Custers & Feltovich, 2007, p.1178), that is, specific combinations of signs and symptoms, and will come to a rapid clinical diagnosis, quite unconsciously (Eva, 2004). This type of clinical reasoning has been referred to as 'non-analytical' (*ibid*, p.100) or 'intuitive' (Pinnock & Welch, 2014, p.254). Eva (2004) proposed that expert clinicians may use non-analytical and analytical/hypothetico-deductive reasoning in a single clinical encounter; upon recognising a pattern of signs and symptoms they may initially use non-analytical

reasoning, generating hypotheses that may then be tested using hypothetic-deductive processes. Eva further suggested that in certain situations the opposite directionality may be seen, and that 'rather than lying along a continuum … [non-analytical and analytical reasoning may be] … complementary contributors to the overall accuracy of the clinical reasoning process' (*ibid*., p.102). In fact, Pinnock and Welch (2014) noted that a 'dual theory of clinical reasoning' (p. 254) was first postulated in the early 20th century. They concurred that whether the expert doctor uses intuitive/non-analytical or hypothetico-deductive/analytical reasoning will respectively reflect more or less familiarity with the particular signs and symptoms; and that both types of clinical reasoning may be used in a single encounter, saying this is recognised as the 'cognitive continuum theory' (*ibid*.).

As demonstrated empirically using the think-aloud method (Patel & Groen, 1986), novices generally employ hypothetico-deductive clinical reasoning, reflecting their relative ignorance of illness scripts. The variation of PBL employed until recently in Year 3 of the featured curriculum was intended to stimulate hypothetico-deductive reasoning, by providing students with data from which to build hypotheses and ultimately arrive at a differential diagnosis. In Years 1 and 2, PBL is instead directed towards students constructing an integrated knowledge base (see 2.2), so one would not expect to see sustained hypothetico-deductive reasoning during the PBL discourse. However, students might, for example, offer reasons to support claims about the credibility of an information source, or to justify favouring one particular hypothesis over another. Thus reasoning *per se* is relevant in the context of this study.

Evaluating arguments.

A third cognitive activity commonly associated with critical thinking is the evaluation of arguments (Missimer, 1995). To do this, the critical thinker needs to identify the writer's/speaker's conclusion(s), to identify and evaluate the supporting reasons, and to identify and consider any underlying assumptions. Sometimes, such assumptions are necessary for an argument to work (Butterworth & Thwaites, 2005) and they should be

made clear. For example, in evaluating options for patient management, the clinician may assume that a patient's priority is to get better; yet patients often prioritise other aspects of their life, even if this conflicts with the health management plan. So the clinician might make a qualified argument, that medication A is more effective than medication B, providing the patient adheres to specific recommendations for taking medication A.

Missimer's (1995) definition omitted the need for criteria against which to evaluate arguments or their underlying reasons. Lipman (1988) defined criteria as particularly reliable reasons for favouring one argument over another and suggested they might include conventions, ideals, or experimental findings. He further defined more generally applicable 'meta-criteria' (*ibid*., p.40), which would include reliability, strength, relevance, coherence and consistency. Paul and Elder (2006b) proposed similar generic criteria, which they termed 'intellectual standards' (p.10). Like Lipman (1988), they suggested relevance; others included clarity, accuracy and precision. The criteria used for evaluation would likely depend on the context. For example, in a clinical context, criteria to evaluate possible diagnoses could include relevance of signs, symptoms and test results. Whereas criteria for evaluation of patient management options might relate to local availability of suitably-skilled personnel and appropriate facilities, the ability of a treatment to prolong life, or to improve quality of life, and so on.

In the PBL context, evidence for students evaluating arguments could take the form of evaluating alternative hypothesised mechanisms of action for a pharmaceutical drug. In step 5 of the PBL process (see 1.3), students might evaluate potential resources for their inquiry; or in step 7, retrospectively evaluate the usefulness of resources.

Making judgments against criteria.

A further cognitive activity associated with critical thinking is the making of judgments against specific criteria (Lipman, 1988; Paul, 1995). One could argue that evaluation

based on criteria, and making judgments based on criteria are one and the same thing. However, judgment implies a deliberate choosing of one thing over another: evaluation of options is necessary, but not sufficient to make a judgment; one also needs to have an impetus for making the judgment. For example, one might evaluate several potential medical texts as being suitable for supporting students' learning, as judged against criteria such as clarity, accuracy, relevance, and so on; however, only when provided with the impetus of needing to make a specific recommendation for the students' booklist would one make a judgment about which single text to select, and additional criteria may be brought to bear, such as cost or predicted longevity.

Moore (2011) found that academics in the disciplines of philosophy, history and literary studies all conceived of critical thinking as something that 'always … involved the making of judgments' (p.265). However, the disciplines differed in the entity that was judged, and the criteria against which judgments were made. In philosophy, the arguments of respective philosophers were judged for their validity, strength and persuasiveness. Historians judged the relevance and usefulness of different sources in the construction of a new understanding of some historical topic. In literary studies, judgment related to the applicability of different conceptual categories, such as genre, to the interpretation of the text.

The criteria against which judgments are made may differ not only between disciplines, but within disciplines. In medicine, Bleakley, Farrow, Gould and Marshall (2003) distinguished different forms of clinical judgement: technical-rational and aesthetic, respectively representing the science and art of medicine. At least for specialities with a visual element - pathology, dermatology, radiology - aesthetic judgement was considered crucial (*ibid*.). Bleakley *et al* (2003) suggested aesthetic judgement might not require critical thinking, since they saw it as unrelated to deductive or inductive reasoning. However, aesthetic judgement may relate to non-analytical reasoning (Eva, 2004). In any case, if critical thinking is defined as the ability to make judgments against specific criteria, there is no reason to suppose those criteria could not include the shape,

texture or colour of an object, such as a skin lesion. An expert dermatologist may judge almost instantaneously that a skin lesion is suspicious, by unconsciously assessing it against relevant criteria and comparing it with exemplars encountered previously. Indeed, Bleakley *et al* (2003) illustrated the degree of discrimination that might be achieved in making aesthetic judgements, saying 'rabbis identified over thirty shades of white in diagnosing leprosy' (p.547), each of which was related to a specific exemplar, such as lime, or the membrane underlying an eggshell.

In a PBL context, as well as learning about situations requiring clinical judgment, and criteria that might be used to make such judgments, students might also make judgments during the discourse; for example, on alternative hypotheses offered by peers.

Meta-cognition.

Fisher (2006) said 'the only realistic way to develop one's critical thinking is through thinking about thinking (often called meta-cognition), and consciously aiming to improve it...' (p.5). Thinking about thinking is a simplistic expression of Flavell's (1979) definition of meta-cognition as 'knowledge and cognition about cognitive phenomena' (p.906). Flavell defined the construct of meta-cognitive knowledge, which is to do with what the individual thinks about the nature of cognitive activities and experiences, such as perceiving one is good at a particular cognitive task; it reflects an 'awareness of the skills, strategies, and resources needed to perform a [cognitive] task effectively' (Reynolds & Wade, 1985, p.308). Conversely, meta-cognitive experiences reflect what the individual feels about the nature of cognitive activities and experiences; for example, the 'sudden feeling that you do not understand something another person has just said' (Flavell, 1979, p.906). Other definitions of meta-cognition include that the thinker monitors and regulates his thinking (Babbs & Moe, 1983; Baker & Cerro, 2000), consistent with Paul's (1995) conceptualisation of critical thinking as a deliberate, purposeful activity, whereby the thinker seeks to constantly improve the quality of his

thinking. Reynolds and Wade (1986) pointed out the parallel with Dewey's (1933) concept of the reflective thinker. Georghiades (2004) stated:

> Meta-cognitive reflection involves the critical revisiting of the learning process in the sense of noting important points of the procedures followed, acknowledging mistakes made on the way, identifying relationships and tracing connections between initial understanding and learning outcome (p.371).

This is particularly relevant to step 7 of the PBL process, when students reflect on the adequacy of their learning. Georghiades (2004) continued: 'meta-cognitive monitoring … requires an element of judgment that is essential in comparing, assessing and evaluating the content of the processes of one's learning …' (p.371). The overlap between meta-cognition and critical thinking is clear.

To summarise, for the purposes of this study, meta-cognition is defined as a critically reflective cognitive activity incorporating awareness, monitoring and improvement of one's thought processes; component constructs include meta-cognitive knowledge, meta-cognitive experience, and appraisal of one's thinking. It overlaps with the concept of self-monitoring, a component of self-directed learning (Garrison, 1997; section 2.3).

One can well imagine meta-cognitive knowledge being evident in a clinical environment when a student or doctor explains how he reasoned towards a particular diagnosis. Meta-cognitive experience might manifest in a student or doctor realising he hasn't understood a colleague's reasoning. The regulatory aspect of meta-cognition may be achieved by the student or doctor reflecting on his reasoning or, potentially, from discussion with peers or seniors. This latter possibility invokes a social dimension to meta-cognitive reflection and critical thinking, which is a theme we will return to. Improved meta-cognition is an expected consequence of PBL (Downing, Kwong, Chan,

Lam & Downing, 2009), since discourse potentially facilitates students to identify, articulate and question their own and each other's thought processes.

To conclude section 3.3.1, the conceptualisation of critical thinking as the application of a set of aligned cognitive - including meta-cognitive - activities would be relevant to this study. Indeed, this was the conceptualisation initially adopted. However, on reflection and initial analysis of empirical data, it became apparent that this conceptualisation failed to take account of social interactions during the PBL tutorial, and it did not facilitate identification of enablers of, or impediments to, critical thinking.

3.3.2. Critical thinking as a critique of dominant discourses.

A related conceptualisation of critical thinking explicitly requires the application of such (meta-)cognitive activities as described above, to dominant discourses; that is, to perspectives regarded as self-evident (Talbot, Bibace, Bokhour & Bamberg, 1996). In clinical medicine, one dominant discourse is the supremacy of quantitative research methodology. Critique of this is important because it reflects a biomedical, reductionist perspective towards clinical problems, and ignores the relevance of qualitative methods to understanding psycho-social problems in medicine.

Writing from the perspective of teaching management undergraduates to have a critical approach, Mingers (2000) proposed a framework for what he termed critical learning, which required one to critique rhetoric, tradition, authority and objectivity: these may respectively be equated to judging the validity of arguments; questioning conventional wisdom, common sense and long-standing practices; being sceptical of the dominant discourse(s); and 'questioning the validity of the knowledge and information that is available' (*ibid*., p.226). Mingers (2000) equated critical thinking with critiquing rhetoric, but Gold, Holman and Thorpe (2002) presented the whole framework as one for critical thinking. This is justified, since each element in the framework requires application of those cognitive activities associated with critical thinking. Note, Gold *et*

al (2002) renamed the fourth element of the framework as critique of knowledge, reflecting their epistemological stance, that knowledge is subjective and contextual.

This conceptualisation of critical thinking is useful for critiquing dominant discourses in medicine and medical education; the latter might include the supposition that education in basic sciences is essential for a medical practitioner. The conceptualisation might be particularly relevant in PBL tutorials featuring ethical or social issues in medicine.

3.3.3. Strong-sense and weak-sense critical thinking.

A third conceptualisation distinguishes between critical thinking that promotes and perpetuates a single, favoured perspective, which may or may not be the dominant discourse, and critical thinking that recognises and acknowledges multiple perspectives. Paul (1995) employed the terms weak-sense and strong-sense critical thinking to distinguish respectively between individuals who only criticise others' thinking, and those who reflect critically on their own. Paul (1995) said weak-sense critical thinkers 'tend to think mono-logically'(p.552), or one-dimensionally, 'within one point of view or frame of reference' (*ibid*., p.543), even where the problem is multi-logical, meaning it should properly be considered from different perspectives. For example, thinking about appropriate ways to distribute a nation's health budget is a multi-logical problem. Relevant perspectives include those of different patient groups, different groups of health practitioners, taxpayers and so on. To take just one of these perspectives into account would be to indulge in mono-logical or weak-sense critical thinking.

In contrast, strong-sense critical thinkers have 'an ability to question deeply ... [their] ... own framework of thought … and to reason dialectically (multi-logically)' (Paul, 1995, p.550). Dialectical thinking is where 'reasoners pit two or more opposing points of view in competition with each other, developing each by providing support, raising objections, countering those objections, raising further objections, and so on' (Paul, 1995, p.527). Therefore a dialectical thinker would not only recognise multiple

perspectives, but would use these to examine and refine his own thinking. Dialectical thinking may be facilitated by dialogue, so one might expect strong-sense critical thinking to be facilitated by the social context of the PBL group.

Garrison (1991) recognised the concepts of weak- and strong-sense critical thinking and described the latter as a 'global and Socratic challenging ... of previously held assumptions and an identification of contradictions in personal and social life' (*ibid.*, p.290). However, it does not always come naturally to individuals to reflect critically on their own beliefs, especially if these are simultaneously held by their peers or profession. Examining the development of critical thinking ability in senior managers participating in a continuous personal development (CPD) module, Gold *et al* (2002) found that participants initially made claims about good management practice that on subsequent analysis were found to have little evidential basis. Recall that the professional issue that stimulated the research in this thesis was a dawning scepticism about the basis for claims made, and initially accepted without question, about the ILOs expected from PBL-based medical curricula.

3.3.4. Critical thinking as argument analysis.

Thus far, a common thread in conceptualisations of critical thinking is evaluation of arguments, including one's own. Some hold argument analysis as the sole or principle aspect of critical thinking (Missimer, 1995). Generally, argument analysis conjures the application of formal logic (Bowell & Kemp, 2005). Kurfiss (1988) defined logic as being 'concerned with the quality of reasoning in an argument' (p.14) and formal logic as analysis of deductive arguments, requiring identification of conclusions, reasons, assumptions and inferences. Formal logic may have contributed to negative perceptions of critical thinking, since some may regard it as too intellectually-demanding, too abstract, only to be applied within the ivory towers of academia. In contrast, informal logic represents 'the study of argument as it is practised in everyday life' (*ibid.*), where problems or conflicts are often complex and may be viewed from multiple perspectives.

Informal logic focuses on inductive arguments, generalisations and fallacies. The forcefulness, or cogency, of an inductive argument rests on the justification of its premises, or reasons.

In his 1958 text, The Uses of Argument, updated in 2003, Toulmin championed informal argument analysis. He devised a model for teaching this, in which the learner identifies arguments of personal interest or professional relevance, and deconstructs these as a prelude to evaluating them. Toulmin (1958, 2003) proposed that arguments may be considered as having three elements: the claim; the data supporting the claim; and the warrant, which is a justification of the way in which the data support the claim. Note that claim is equivalent to conclusion; data is equivalent to grounds, reasons or evidence; whilst warrant is equivalent to justification in other writings on this topic, and effectively elaborates why the data does indeed offer support for the claim. To illustrate the distinction between the data and warrant for a claim, suppose a student claims he was unable to study effectively and gives as his reason (data) the fact that he was working on a specific level of the library; the warrant might be that there are more distractions on that level. Analysing the warrants for arguments may reveal the types of argument being used and the social discourses on which the claim draws - that is, whether it is based on particular ways of thinking about the social world. Moreover, analysing warrants will ideally require the thinker to consider multiple perspectives.

This approach to argument analysis is of obvious utility in professional practice. In particular, for medical undergraduates and practitioners it offers real possibilities for promoting reflection and for identification of CPD needs. It seems unlikely that much in the way of structured argument analysis, whether by formal or informal logic, would be demonstrated during PBL tutorials, since the discourse is relatively unstructured. Nevertheless, in response to claims made by students, questioning by peers or the facilitator could potentially lead to identification of reasons for the claim and even identification of warrants.

3.3.5. Critical thinking as a mechanism for problem-solving or conflict resolution.

Several authors (Brookfield, 1987; Dewey, 2009; Garrison, 1991, 1992; Paul, 1995) conceptualise critical thinking as a mechanism for solving problems or resolving conflict or uncertainty, and this likely has utility for medical professionals, who will need to solve clinical problems, such as how to manage a specific case; who will need to know how to proceed in the face of conflict, such as opposition from a patient or their family to a suggested health management plan; and who will need to deal with uncertainty over the best way to proceed in managing difficult cases. Some authors have broadened the definition of a problem in the context of critical thinking, and this is helpful in considering the utility of the problem-solving conceptualisation. Thus Garrison (1992) suggested the critical thinker seeks to 'explore ways to reduce dissonance, consider alternative possibilities, or attain a more satisfactory understanding of a situation or experience' (pp.137-8). This built on Dewey's (2009) conceptualisation of critical thinking as a means of dealing with uncertainty, and on Brookfield's (1987) conceptualisation of critical thinking as identifying and challenging assumptions, and imagining alternatives (see also 3.3.6). Framed in Garrison's terms, a problem could be an unsatisfactory initial understanding of a biological or clinical concept, whilst newly-constructed knowledge arising from reflection, inquiry and/or discourse would be the solution. This is clearly relevant in the context of the PBL tutorial.

Garrison's 5-stage model for thinking critically about a problem.

Building on Dewey's (1933) five stages of reflective thinking (see 3.2.3), Garrison (1991) also conceptualised critical thinking as occurring in five stages: problem identification, problem description, problem exploration, applicability and integration. Table 3.1 provides a descriptor for each stage.

Table 3.1.: Garrison's Five Stages of Critical Thinking.	
Stage	Descriptor
Problem identification	A disorientation or trigger leads to recognition of a problem or personal dissonance, at odds with the individual's previous knowledge or perspective (e.g., appreciation of a gap in one's knowledge or a different perspective).
Problem description	By gathering information, questioning assumptions and collaborating or interacting with others, the individual comes to a better understanding of the problem.
Problem exploration	A creative phase in which the individual may elaborate the issue, search for an explanation to resolve the problem, and explore alternative ideas to resolve the problem. The most favoured explanation may be considered an hypothesis.
Applicability	Through abstract thought, the individual determines whether one of the alternative explanations is sufficient to resolve the problem and searches for personal meaning and a new perspective on, or understanding of, the problem.
Integration	Integration of a new perspective or confirmation and integration of new knowledge; requires collaboration and interaction. This phase may end in satisfactory resolution of the problem, or may be a trigger to further learning.
Garrison (1991, p.295) conceptualised critical thinking as a process comprising five stages, described in this table, and reminiscent of Dewey's (1933) reflective thinking.	

Garrison's five stages effectively serve as a model for critical thinking, where model is used in the sense of process; those stages or steps one may progress through to achieve critical thinking. Educators may seek suitable models to facilitate critical thinking by students, and models of critical thinking potentially offer coding schemes for empirical

research into critical thinking within specific learning environments, which is clearly relevant in this context. However, Garrison (1991) observed that critical thinking may not necessarily proceed in the linear fashion implied by his model, and it may not be easy to recognize the various stages.

The nature of problems that merit critical thinking.

Paul (1995) said 'we think critically when we have at least one problem to solve' (p.93). This suggests critical thinking may only be applied in situations where a problem is clearly defined, or where it is recognised there may well be different ways of doing things. However, certain situations or issues may not be perceived as problematic. Deep-seated and widely-held assumptions may lull the individual, a profession, or society into believing there is no problem with, or alternative to, the *status quo*. Application of critical thinking to an apparently unproblematic and deeply-held personal belief, or a professional or societal norm, could raise awareness about assumptions that are commonly held and implicit, and could reveal that the *status quo* is not in fact ideal. For example, in medicine, therapies that were of proven clinical benefit in randomised controlled trials (RCT) were generally regarded as gold standard treatments, until it became appreciated that RCT participants were often adult males, and differences between male and female physiologies, or between adults' and children's physiologies, potentially called into question the usefulness of some gold standard treatments for certain groups of patients.

Brookfield (1987) also saw problem-solving as the purpose of critical thinking. In his seminal text, Developing Critical Thinkers, he argued that critical thinking should not be confined to academia, but that it had direct and important application in everyday life, and it had likely been applied by anyone who had ever weighed up the pros and cons before making a decision about their personal life, working environment or political views. This aspect of his conceptualisation of critical thinking would be relevant to the

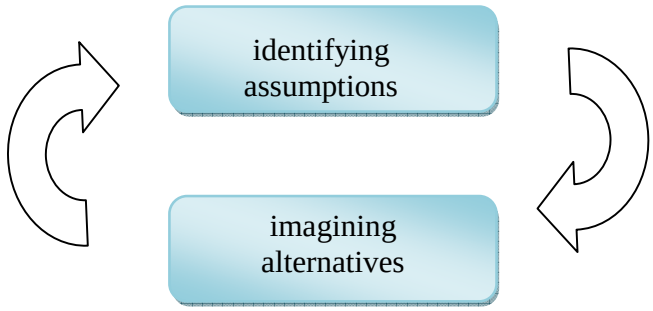
practising clinician as he/she critiques working practices, work-life balance, and other such everyday matters.

Although Brookfield (1987) believed that critical thinking was often directed towards solving problems, he moved away from the negative connotations of problem-solving - conflict, difficulty, uncertainty - and proposed that critical thinking could be stimulated by positive as well as negative experiences; thus another purpose of critical thinking could be the desire to reproduce successful experiences. Brookfield's notion of positive stimuli for critical thinking would be particularly useful to medical students or graduates in helping them to identify personal and professional values, and CPD needs. However, in the context of the PBL tutorial, it seems likely that any critical thinking ensuing from the process of understanding a clinical problem will be associated with the more negative connotations of problem-solving.

3.3.6. Creative thinking as a component of critical thinking.

Brookfield (1987) moved away from the notion that critical thinking is mainly about making judgments and introduced an element of creativity. Specifically, he proposed that critical thinking involved two broad activities: identifying and challenging assumptions; and imaging alternatives, this latter being the creative component. He argued that critical thinking is not achieved unless both aspects are present. Brookfield's (1987) conceptualisation is depicted in Figure 3.1.

Figure 3.1.: Critical thinking as a cycling between two broad phases of identifying assumptions and imaging alternatives (Brookfield, 1987).



Stein (1953) defined creativity as the production of something novel and useful. By novel, Stein (*ibid*.) meant the creative product 'arises from a reintegration of already existing … knowledge, but when it is completed it contains elements that are new' (p.311). Daniel and Auriac (2009) suggested 'creativity pre-supposes skills such as inventing, associating, suggesting alternatives, making analogies, [and] formulating hypotheses' (p.418). Introducing the notion of creativity into the concept of critical thinking is certainly valuable with regard to real-life problems, because there seems little point in using critical thinking to recognise one's current situation as unsatisfactory or untenable, without imagining how things might otherwise be.

Garrison (1991) argued that critical thinking about problems encompasses creative thinking. This is consistent with Newell, Shaw and Simon (1958), who equated creative thinking with problem-solving, where the problems were new or especially difficult. In fact, Garrison (*op. cit.)* suggested that some of the difficulties in defining critical thinking have been due to scholars taking too narrow a view of what constitutes critical thinking. Drawing on others, Garrison (1991) proposed that 'critical thinking is a larger process which includes not only discovery (the intuitive and creative processes) but justification (the evaluative and logical-reasoning processes)' (p.291). He proposed that critical thinking involves a cycle of directed, logical, evaluative thinking - akin to Dewey's reflective thinking or the conceptualisations of critical thinking discussed in 3.3.1 to 3.3.5 - interspersed with the creative thinking necessary to generate possible solutions to problems, which could then be judged through further directed thinking. The parallel between this conceptualisation and Brookfield's is illustrated in the first two columns of Table 3.2. Critical thinkers would cycle from one phase to the other.

Paul and Elder (2005) also discussed the inter-relatedness of critical and creative thought, saying 'these supposed poles of thinking … are inseparable aspects of excellence of thought' (p.4). They made the interesting suggestion that stereotypical portrayal of critical and creative types in mass media may have contributed to the notion that criticality and creativity cannot co-exist in an individual.

Table 3.2.: Conceptualisations of critical thinking as encompassing two phases.				
Brookfield		Garrison's incorporation of creative thinking	Garrison's internal and external worlds	Garrison's cycle of reflection and discourse
1st phase	Identifying assumptions	Justification/ validation/ verification	External/shared	Discourse
2nd phase	Imagining alternatives	Discovery/ creativity/	Internal/private	Reflection
Brookfield (1987) and Garrison (1991, 1992) conceptualised critical thinking as a cycling between two broad phases. The table shows how Brookfield's (1987) descriptors for these two phases, identifying assumptions and imaging alternatives, align with descriptors given in Garrison's various writings (1991, 1992).				

Maudsley and Strivens (2000b) expected that brainstorming by medical students would encourage divergent thinking, which is associated with creativity and is the generation of multiple solutions or ideas. In a non-PBL context, Taylor, Berry and Block (1958) found that group participation in brainstorming actually inhibited creative thinking by psychology students; but in a systematic review, Chan (2013) identified studies showing that PBL-based nurse education courses promoted creative thinking, although she acknowledged the limitation that they were perception studies with multiple outcome measures. Of the activities that Daniel and Auriac (2009) associated with creativity, formulating hypotheses would clearly apply in a PBL context, as students aimed to account for clinical symptoms or pathological findings in the scenario.

3.3.7. Critical thinking as a cycle of reflection and discourse.

Garrison (1991) pointed out that critical thinking is often conceived as an activity conducted in the internal, private world of the thinker's mind; this observation could apply to the conceptualisations discussed thus far. However, critical thinkers assimilate and apply knowledge constructed and articulated by those who have gone before, so their critical thinking necessarily relies on the cognitive activity of others. Furthermore,

for critical thinkers to test the product of their own thinking, they must present it to the external world (Table 3.2, third column). Garrison (1992) argued that 'it is not sufficient to simply self-reflect critically on an experience or idea' (p.146); the critical thinker needs to engage in discourse to validate the outcome and hence the quality of his thinking. Discourse implies purposeful sharing of ideas and conclusions in the expectation of constructive criticism. Note that it may refer to written communication, such as a position paper or a description of a theoretical framework; but it may also refer to verbal communication, which is relevant to the PBL context of this research.

Thus Garrison (1991) conceptualised critical thinking not only as alternating phases of creative thinking and justification, but also as a cycle of reflection and discourse (Table 3.2, fourth column), and acknowledged his debt to Dewey's (3.2) theory of reflective thinking (Dewey, 1933). However, Garrison's phase of reflection correlated with the creative thinking phase of critical thinking, whereas his discourse phase was closer to Dewey's definition of reflective thinking (see 3.2; also Table 3.2). Garrison (1991) also suggested that the critical thinker oscillates between the internal/private world of ideas, which coincides with the creative, reflective phase; and the external/shared world of knowledge, which coincides with justification and discourse.

Incorporating Garrison's (1991) five stages of critical/reflective thinking, a problematic situation occurs in the shared world: identification and description of the problem take place and the thinker seeks information, still in the shared world. Gradually, the thinker's cognitive activity moves into the private world as he forms concepts and hypotheses - creative thinking - and applies these to the problem. The thinker must then integrate his new understanding of the problem, his newly-constructed knowledge, with the knowledge base of the shared world, in the justification component of critical thinking. Table 3.3 shows how we may align conceptualisations of critical thinking as having five stages or two phases; successive encounters with the external world are represented by the white rows, whereas the internal world is represented by the turquoise row.

Table 3.3.: Alignment of five-stage and two-phase conceptualisations of critical/reflective thinking.

Dewey's 'reflective thinking' (1933)	Brookfield (1987)	Garrison's 5 stages (1991)	Garrison's incorporation of creative thinking	Garrison's cycle of 'reflection' and 'discourse'	Garrison's 'internal and external worlds'
Problem	Identifying assumptions	Problem identification	Justification	Discourse	External (with others)
Intellectual-isation of problem		Description			
Reviewing possible solutions	Imagining alternatives	Exploration	Discovery/ creativity/	Reflection	Internal (one's private thoughts)
Mental elaboration		Applicability			
Verification (testing favoured hypothesis)	Identifying assumptions	Integration	Justification	Discourse	External

The table illustrates how we may align five-stage conceptualisations of reflective (Dewey, 1933) or critical (Garrison 1991) thinking with biphasic conceptualisations of critical thinking (Brookfield, 1987; Garrison, 1991, 1992). The white rows represent cognitive activity in the social world; the turquoise represents cognitive activity in the mind of the individual.

During the PBL tutorial, specifically during step 6 of the PBL process followed at the featured medical school (see 1.3), students share their personal constructions of knowledge (Van der Vleuten *et al*, 2000), arrived at in the intervening period between tutorials. A creative phase of critical thinking, their individual knowledge construction, has taken place outwith the tutorial; whilst within the tutorial, by articulating these individual knowledge constructions, students engage in the justification component of critical thinking. Potentially, the creative component of critical thinking could also occur during the PBL tutorial, especially during step 3 of the PBL process, where students brainstorm issues and attempt to generate plausible mechanisms, explanations and/or hypotheses. When a student articulates an hypothesis to explain some phenomenon, he

is demonstrating the justification aspect of critical thinking by testing his hypothesis on the group, but the inference is that this was immediately preceded by creative thinking to generate the hypothesis, so articulation of an hypothesis is proxy for creative thinking in the tutorial setting.

Discourse is essential for solving problems at a societal level. Paul (1984) observed that society increasingly needs to address multi-perspective problems. A clinically-relevant example would be how to care for our growing elderly population. To an extent, personal or community values come into play in this type of collective critical thinking: in this example, the relative importance particular individuals/communities attach to self-determination, duty of care, and family. Care of the elderly is one of the PBL scenarios tackled by first year students in the featured medical curriculum, and some of the data described in Chapters 6 and 7 relates to critical thinking on this topic.

To summarise: critical thinking may be seen at least partly as a social activity, which requires interaction between the thinker and the external/shared world. External influences stimulate the thinker to undertake the creative component of critical thinking; then the thinker articulates the product of his creative thinking to the external world in order to validate that thinking. Thus critical thinking may best be described not simply as a constructivist concept, but in terms of socio-constructivism.

3.3.8. Socio-constructivism applied to critical thinking.

Socio-constructivism, or social constructivism, is a theory attributed to Vygotsky (1978): this text, Developing Minds, is a posthumous translation of Vygotsky's essays by a group of scholars. According to Lipman's (1991) interpretation of Vygotsky, learning occurs via social interactions followed by individual internalisation of information, leading to deep understanding; that is, understanding of the associated concepts, rather than surface learning, or factual recall of a topic. Whilst individuals' cognitive activity is stimulated within the social environment, this does not necessarily

lead to shared cognition (*ibid*.). Hmelo-Silver and Barrows (2008) proposed that learning in the social context of a PBL group leads to collective knowledge building. However, whilst group members may be engaged in collective activity to construct knowledge, and whilst they may individually grasp the same details of a specific concept, constructivist principles (Van der Vleuten *et al*, 2000) dictate that they cannot have identical knowledge constructions to others in the same social group.

Vygotsky developed his theories in the context of working with children, so one might question whether they apply in higher education (HE), and to medical education in particular. A May 2012 search of the ERIC database for articles mentioning *Vygotsky* in an HE context gave 163 hits. Most of these were in the field of online-learning/computer-mediated-communication. There was no explicit application of Vygotsky in undergraduate medical education, but Hung and Tan (2004) discussed how Vygotskyan concepts might apply to the training or coaching of medical practitioners. Searching instead for *socio/social constructivism* identified Hmelo-Silver and Barrows' (2006, 2008) studies on the role of the facilitator in helping students to construct knowledge in a social context; whilst Gleeson (2010) applied socio-constructivist principles in participatory action research on the development of an educational programme for trainees in palliative medicine. Recent (May 2014) searches have not revealed additional, relevant articles.

It is clear that certain Vygotskyan concepts could apply in a PBL context; for example, the 'zone of proximal development' (ZPD: Vygotsky, 1978, p. 86). The ZPD refers to learning challenges that are beyond the current capabilities of the learner working in isolation, but achievable if the learner is guided, or if he collaborates with more capable peers. In a classroom context, the teacher can provide guidance by means of activities that are collectively referred to as scaffolding (Wood, Bruner & Ross, 1976); that is, ways of 'supporting learners in complex or unfamiliar environments' (Simons & Ertmer, 2005, p.4). Saye and Brush (2002) distinguished hard scaffolding, 'static supports that can be anticipated and planned in advance' (p.81), from soft scaffolding, which is

'dynamic and situational' (*ibid*., p.82). Writing in the context of history education in multimedia environments, they suggested that links or resources embedded in a database (Brush & Saye, 2002) or the structure of the database itself (Saye & Brush, 2002) were forms of hard scaffolding, whereas 'soft scaffolding requires teachers to continuously diagnose the understandings of learners and provide timely support based on student responses' (*ibid*., p.82). Scaffolds have been investigated in online problem-based secondary school education in social studies/history (Brush & Saye, 2008; Saye & Brush, 2004, 2006, 2007) and in science, maths and technology (Simons & Ertmer, 2005; Simons & Klein, 2007); and in PBL-based undergraduate medical education (De Grave *et al*, 1999; Greening, 1998; Hmelo-Silver & Barrows, 2006, 2008; Lu, Lajoie & Wiseman, 2010; Papinczak, Tunny & Young, 2009). In PBL, scaffolds may help initiate the inquiry, assist students in integrating concepts and addressing misconceptions, and promote reflective thinking (Simons & Ertmer, 2005).

In the PBL context of the featured curriculum, the ZPD of medical students might be related to their inadequate understanding of a biological or clinical concept. Hard scaffolding might constitute details in the PBL scenario, since these would initiate the inquiry; or the PBL process might provide hard scaffolding, since step 7 promotes reflective thinking. Soft scaffolding might include the use of probing questions (Gilkison, 2003; Hmelo-Silvers & Barrows, 2006, 2008; Wilkie, 2000) to help students justify their thinking; or to prompt them to participate in the creative component of critical thinking, forming hypotheses and integrating knowledge. Moreover, in a social setting, silent scaffolding may be provided by supportive or illustrative gestures (Carter, Weibe, Reid-Griffin & Butler, 2006).

Collaboration with more able peers could be directly achieved through PBL discourse. The peer group may provide for second teaching (Novemsky, 2003), defined as:

> teaching [that] occurs when the collective wisdom of a collaborative group acts as a mentor to its individual members. For peer groups in

> general, this collective wisdom is most likely to fall in the zone of proximal development for most of its individual members. This collective wisdom is created then recreated through group collaboration (p.6).

Second teaching follows on from first teaching, the initial presentation of information and concepts in a lecture or other teacher-led format. This resonates with experience of PBL tutorials at the featured medical school. Where timetabling constraints dictate that relevant lectures precede the presentation and brainstorming of a new PBL scenario, it is clear that students grasp the concepts in the lecture to varying degrees, if at all; often, only one or two students in the group will have really understood the gist of the lecture; and they will try to convey their understanding to their peers, thereby helping some of their fellow students to gain a better understanding of the topic.

In summary, we might reasonably expect aspects of Vygotskyan socio-constructivism to apply to PBL. Specifically, social discourse during PBL tutorials could facilitate critical thinking in the sense of helping students to achieve better understanding of topics, as a consequence of students using second teaching, and particularly as a consequence of hard and soft scaffolding.

3.3.9. The Community of Inquiry.

The use of social discourse to facilitate critical thinking has been embraced by those who developed and applied the concept of the community of inquiry (CoI), which refers to a group of individuals who work together to undertake an inquiry - or solve a problem - and who do so primarily through the vehicle of discourse. A variation, community of enquiry, has been used by Christie, Cassidy, Skinner, Coutts, Sinclair, Rimpilainen and Wilson (2007) in the context of collaborative enquiry to foster educational research across different professional contexts. This group has also investigated how communities of practice (Lave & Wenger, 1991) and communities of philosophical

inquiry (COPI: McCall, 2007) may be nurtured to facilitate educational research (Cassidy, Christie, Coutts, Dunn, Sunclair, Skinner & Wilson, 2008). However, these researchers did not explicitly focus on the use of these social contexts to promote critical thinking.

Baumfield (2004) attributed the first use of CoI to Charles Sanders Peirce (1839-1914), who applied it to the creation of new knowledge by the scientific community. John Dewey developed the theme, but in recent years it has been especially associated with Mathew Lipman.

Philosophy for Children.

Lipman is a former philosophy professor who became concerned at the lack of higher-order thinking amongst his students; higher-order thinking encompasses critical thinking (see below). With a colleague, Ann Margaret Sharp, he developed a programme called Philosophy for Children (P4C: Lipman, 1984, 1991, 1998), which has been implemented in some American elementary schools - equivalent to UK primary schools - since the 1980s, but also in countries worldwide, including the UK. A typical P4C class begins with the children reading from a novel with a metaphysical or ethical topic. They think of questions arising from the story, the teacher records these, then the class decides the order in which they will answer them. The pupil who came up with a specific question relates his thoughts; other students are then expected to agree or disagree, but they also need to provide reasons. It is easy to see how this format would promote critical thinking consistent with one or more of the conceptualisations already discussed. The questions exemplify problems or dissonance that could trigger critical thinking (Brookfield, 1987; Dewey, 1933; Garrison, 1991; Paul, 1995); the prioritisation of tackling the problems potentially requires evaluation according to criteria (Paul, 1995) - for example, most important, most interesting; thinking of an answer to one's own question requires reflection, reasoning and hypothesis formation, hence both creative thinking and justification (Garrison, 1991, 1992); and choosing to agree or

disagree whilst giving one's rationale is equivalent to the justification phase of critical thinking (*ibid.*).

In their systematic review of ten studies on P4C, limitations such as inclusion of only pre/post-test study designs aside, Trickey and Topping (2004) found a mean effect size of 0.43, a moderate effect in favour of P4C promoting thinking, listening, reasoning, language skills, curiosity, motivation, self-confidence and/or willingness to speak in front of others. Baumfield (2004) observed that children who experienced P4C showed increased willingness to consider multiple possibilities, fewer demands for set answers from the teacher, and a shift to learner-centredness, which was also seen by Topping and Trickey (2013) when they investigated the use of a more structured and scaffolded P4C-style intervention.

The parallels between the benefits seen for schoolchildren exposed to the P4C programme, and the ILOs for PBL in a medical education setting are such that the CoI concept has clear relevance for PBL. However, Pardales and Girod (2006) pointed out that in professional, discipline-based CoIs, it is necessary to limit the possible topics for inquiry, to ensure that where progression and prospects are based on 'high-stakes tests' (*ibid*. p.308), students are not disadvantaged by straying too far from the mandated curriculum. This captures the conflict faced by medical educators in the UK, who in designing their curricula must be mindful of the requirements of the General Medical Council and postgraduate deaneries. Thus the degree of freedom that seems to exist in the P4C classroom, at least prior to the recent Topping and Trickey (2013) study, cannot be wholly replicated in the medical education context.

For all it seems to apply to the PBL context, the CoI is not a concept with obvious currency in medical education. Searching the ERIC and PubMed databases in May 2012 for the term *community of inquiry*, or for *community of inquiry* plus *medical/medicine*, produced no hits. In contrast, the term *community of practice* (CoP; Lave & Wenger, 1991) generated 604 hits in ERIC, though only nine of these were related to medicine,

and to the practice setting rather than undergraduate education. CoPs are social constructs and participants share a common purpose, but this is not necessarily learning or inquiry. There has been no suggestion that CoPs promote critical thinking by participants, so the construct does not seem especially relevant to the research described in this thesis. Another construct that relates to the formation of social groups for a specific purpose is the community of learners. Searching the ERIC database for this term in May 2012 produced 540 hits, of which only 3 were related to medicine. Moreover, there was no explicit association between the concept of community of learners and critical thinking. In studying online discussions about palliative care, Kim, Farber, Kolko, Kim, Ellsbury and Greer (2006) utilised constructs from a CoI framework (see 3.3.10), but did not acknowledge this, or use the term, CoI. Overall, socio-constructivist approaches have been little-used in medical education research and, in particular, the CoI construct has not been explicitly utilised. Nevertheless, of the various social constructs described in the literature, Lipman's CoI seems the most appropriate for this study.

Critical thinking in Lipman's Community of Inquiry.

Members of Lipman's CoI (2003) practise critical thinking. His own definition of critical thinking (Lipman 1984, 1988, 1989) was that it should employ criteria, be assessed by appeal to criteria, be self-correcting, and be sensitive to context. The concepts of criteria and meta-criteria have been discussed (see. 3.3.1). Regarding self-correction, Lipman (1988) equated this with meta-cognition, one of the cognitive activities associated with critical thinking (see 3.3.1). It also relates to Paul's strong-sense critical thinking (see 3.3.3), since self-correcting behaviour requires one to consider and recognise flaws in one's own thought processes. Lipman (1988) argued that the social group facilitates participants' critique of their own thinking, since:

> members of the community begin looking for and correcting each other's methods and procedures. Consequently, insofar as each

> participant is able to internalise the methodology of the community as a whole, each participant is able to become self-correcting in his or her own thinking (p.41).

That is, they follow the example of the group. With the potential for students to question one another's reasons, conclusions or resources, as well as the fact that step 7 of the PBL process should encourage reflection and meta-cognition, the PBL tutorial at the featured medical school is well-placed to foster the self-correcting component of critical thinking.

Sensitivity to context requires recognition 'that some meanings do not translate from one context or domain to another' (Lipman, 1988, p.42). Brookfield (1987) noted that culture and place in history are two important contextual parameters. Critical thinking in the clinical domain requires sensitivity to context. For example, critical thinking applied to public health problems would need to take into account social, political and economic factors, as well as health aspects. Critical thinking applied to health management options needs to take into account the preferences and lifestyle choices of patients. Therefore, PBL tutorials based on such clinical scenarios offer the potential for sensitivity to context. Lipman (1989) argued that 'crude, raw, problematic materials' (p.6) were necessary to stimulate critical thinking in CoIs. Ill-structured clinical cases such as those featuring in PBL tutorials potentially provide a suitable stimulus.

Caring thinking in Lipman's Community of Inquiry .

Baumfield (2004) noted that Lipman 'stresse[d] the affective and conative aspects of thinking' (p. 80). Affective thinking is concerned with feelings or emotions; conative thinking is concerned with impulses or actions. Lipman (1995) viewed both of these as subsets of caring thinking. He suggested (*ibid*.) that affective thinking reflects caring about or valuing someone or something. Lipman (1995) gave the example that indignation is an emotional response when we are confronted with a situation we can

rationalise as being inappropriate or unwarranted. In the PBL context, affective thinking might apply when discussing a scenario featuring an ethical principle, such as autonomy; or it might manifest as thinking about some aspect of group dynamics, such as the degree to which students are equally prepared for and engaged in the discourse.

Regarding conative thinking or, as he called it, active thinking, Lipman (1995) suggested this reflects caring in the sense of taking care of something. In a clinical context, conative thinking might be demonstrated in proposing a health management plan based on differential diagnosis of the patient's condition. In a PBL context, conative thinking might be demonstrated in discourse about accessing resources, or about scenarios that include diagnosis, management or treatment of patients.

Lipman saw critical, caring and creative thinking as three aspects of higher-order thinking. What he termed critical thinking seems to equate more with identifying assumptions (Brookfield, 1987) or the justification phase of critical thinking (Garrison, 1991, 1992; Tables 3.2, 3.3). If we take this to be the case, then caring thinking is what Lipman adds to Brookfield's and Garrison's conceptualisations of critical thinking. As discussed, caring thinking is relevant to medicine and to the PBL context, which adds to the relevance of Lipman's CoI as a theoretical framework for this study.

3.3.10. The Community of Inquiry Framework.

Drawing on Lipman's (1991, 2003) ideas on the CoI, and working in the context of computer-mediated-communication (CMC) in a HE setting, Garrison, Anderson and Archer (2000) developed the Community of Inquiry Framework (CoI Framework, Table 3.4) as a theoretical basis for conducting empirical research into online learning. Based on generic theories of teaching and learning (Garrison, Anderson & Archer, 2010), this framework potentially has applications in face-to-face CoIs and has indeed been utilised in face-to-face tutorials (Garrison, 2007; Vaughan, 2010; Vaughan & Garrison, 2005). Thus there is every expectation that it may be applied in the PBL context. The CoI

Framework includes students and teacher(s) as key participants; whilst the educational experience, learning, arises from the interaction of three constructs, or elements: cognitive presence, social presence and teaching presence (Table 3.4).

Table 3.4.: Community of Inquiry Framework.

Elements	Categories	Indicators (examples)
Cognitive presence	Triggering event	Sense of puzzlement
	Exploration	Information exchange
	Integration	Connecting ideas
	Resolution	Application of new ideas
Social presence	Emotional expression	Emotions
	Open communication	Risk-free expression
	Group cohesion	Encouraging collaboration
Teaching presence	Instructional management	Defining and initiating discussion topics
	Building understanding	Sharing personal meaning
	Direct instruction	Focussing discussion

The table illustrates the Community of Inquiry Framework developed by Garrison et al (2000, p.89) to analyse discourse in asynchronous online learning environments. The Framework comprises three elements (constructs): cognitive, social and teaching presence. Also shown are categories within each element, and examples of indicators for each category.

Cognitive presence.

Cognitive presence, regarded as the 'most basic to success in higher education' (Garrison *et al*, 2000, p.89), was defined as 'the extent to which the participants in … a [CoI] are able to construct meaning through sustained communication' (*ibid.*). Construction of meaning is consistent with Garrison's (1991) perspective on problem

resolution (see 3.3.5). Moreover, the categories for cognitive presence - triggering event, exploration, integration and resolution - encompass all those aspects of critical thinking proposed in Garrison's (1991, 1992) earlier writing (see 3.3.5 and 3.7). Although Garrison at that point described five stages of critical thinking, building on Dewey's five stages of reflective thinking (section 3.2; Dewey, 1933; Table 3.3), in writing about the CoI Framework he apparently combined problem description and problem exploration into the exploration stage, or category (Table 3.4). In some studies, Garrison and colleagues focused exclusively on the cognitive presence construct (Garrison, Anderson & Archer, 2001; Garrison & Cleveland-Innes, 2005; Kanuka & Garrison, 2004; Vaughan & Garrison, 2005). In so doing, they generally utilised a refined model for demonstrating cognitive presence: the Practical Inquiry Model (Garrison *et al*, 2001).

Social presence.

Social presence was defined by Garrison *et al* (2000) as 'the ability of participants …to project their personal characteristics into the [CoI]' (p.89) and appear as 'real people' (*ibid*.), bearing in mind the authors were writing about the virtual environment of CMC. Social presence in CMC has been much-studied (Garrison, 2007; Garrison & Arbaugh, 2007; Gunawardena, 1995; Gunawardena & Zittle, 1997; Richardson & Swan, 2003; Rourke, Anderson, Garrison & Archer, 1999; Swan, 2002, 2003, 2004; Swan & Shih, 2005; Wegerif, 1998), although the names and characteristics of component constructs vary. In their CoI Framework, Garrison *et al* (2000) defined social presence as comprising emotional expression, open communication and cohesion (Table 3.4). Emotional expression is elsewhere described as effective (Garrison, 2007) or affective (Swan, 2002; Swan & Shih, 2005) expression; in text-based CMC this reflects the use of emoticons (Garrison *et al*, 2000) or specific text to project humour, feelings or personal values (Swan & Shih, 2005).

By supporting discourse, social presence is thought to indirectly facilitate critical thinking (Rourke *et al*, 1999). However, interaction *per se* does not necessarily lead to

meaningful learning (Garrison & Cleveland-Innes, 2005). Garrison (2007) reviewed studies showing that in face-to-face CoIs, indicators of emotional expression and open communication decreased as cohesive indicators increased. Establishing social relationships may be necessary but not sufficient for cognitive presence to manifest; Garrison (2007) stressed the need for evolution of social presence from open communication to purposeful communication, if it is to facilitate cognitive presence.

Teaching presence.

Teaching presence relates to the design of the educational experience, and to the facilitation of learning (Garrison *et al*, 2000). The original CoI Framework had three catagories of teaching presence: instructional management, direct instruction and building understanding (Table 3.4). The first and third of these have subsequently been termed instructional design and organisation, and facilitating discourse, respectively (Anderson, Rourke, Garrison & Archer, 2001; Garrison, 2007). These categories were validated in an empirical study by Arbaugh and Hwang (2008), although Shea, Frederickson, Pickett and Pelz (2003) found only two categories, possibly because the undergraduates who completed their survey were 'not … sophisticated enough to distinguish between facilitation and direct instruction' (Garrison, 2007, p.68).

Faculty will generally be responsible for the design element, and in the PBL context this would be reflected in the PBL process itself, the scenarios, and in the occasional teaching aids that are introduced during the process. These are all examples of hard scaffolding (see 3.3.8) and equate to the teaching presence category of instructional design and organisation (Anderson *et al*, 2001). Soft scaffolding equates to direct instruction or facilitating discourse, and is generally provided by the facilitator, although in the PBL context the chair shares this function, and other students may contribute. In any case, teaching presence is clearly relevant to the PBL context.

In recent years, a desire to produce generalisable findings has led CoI researchers to use quantitative methods to verify the framework empirically, and to develop quantitative instruments to conduct large-scale studies (Arbaugh, 2007; Arbaugh, Cleveland-Innes, Diaz, Garrison, Ice, Richardson & Swan, 2008; Garrison, Cleveland-Innes & Fung, 2004; Shea, Li & Pickett, 2006). Methodological (Rourke, Anderson, Garrison & Archer, 2001) and conceptual (Rourke & Kanuka, 2009) issues notwithstanding, Garrison and colleagues anticipate a continued role for the CoI Framework in understanding CMC (Akyol, Arbaugh, Cleveland-Innes, Garrison, Ice, Richardson and Swan, 2009; Garrison *et al*, 2010). The Framework also offers a theoretical perspective and research tool with which to investigate critical thinking in face-to-face social contexts, such as the PBL tutorial.

3.3.11. Conclusions from critique of definitions and conceptualisations of critical thinking.

To summarise section 3.3, various conceptualisations of critical thinking have been presented and their relevance to the practice of medicine, to medical education and to the PBL context has been discussed. Some conceptualisations fail to take account of the need for, and impact of social interaction on critical thinking, and are therefore less helpful for the purposes of this study. Garrison's (1991, 1992) conceptualisation of critical thinkers oscillating between the external/shared and internal/private world brings in the need for social interaction for critical thinking, whilst Brookfield's (1987) and Garrison's (*op.cit*.) writings are helpful in identifying the thinking that may occur in these external and internal worlds: thus, the external world is where the thinker engages in identifying assumptions/justification/discourse; whilst in the internal world, the thinker engages in imagining alternatives/creative thinking/reflection.

Lipman's (1989, 1991, 1995) interpretation of Vygotskyan socio-constructivist theory is relevant to this study. More particularly, Lipman's (1991, 2003) socio-constructivist CoI is applicable to the PBL context. Although they were developed primarily in the context

of CMC, the CoI Framework (Garrison *et al*, 2000) and the derivative Practical Inquiry Model (Garrison *et al*, 2001) are anticipated to be useful in identifying cognitive presence, a proxy for critical thinking, in face-to-face contexts, including the PBL tutorial. Because this study is concerned with enablers of and impediments to critical thinking, the comprehensive CoI Framework, with its additional constructs of social and teaching presence, is more relevant than the Practical Inquiry Model.

3.4. My conceptual framework.

This section spells out my conceptual framework for critical thinking in a PBL context, the influences on which this draws, and my adaptation of Garrison *et al's* (2000) CoI Framework for the purposes of this study.

Students in a PBL group may be regarded as a CoI (Lipman, 1991, 2003) that undertakes inquiry into biological or clinical concepts, through the vehicle of discourse. Consistent with Lipman's (1991, 2003) interpretation of Vygotskyan (1978) socio-constructivism, PBL group members may help one another to reach improved knowledge constructions, via scaffolding (Wood *et al*, 1976) and second teaching (Novemsky, 2003). The driver for inquiry is an inadequate understanding of a biological/clinical concept, consistent with Garrison's (1991) definition of a problem that may be addressed by critical thinking. There is an expectation that CoIs will engage in critical thinking (Lipman, 1991, 2003) as viewed from a socio-constructivist perspective. Relevant conceptualisations of critical thinking are those that require the thinker to validate his thinking through discourse (Garrison, 1992) and those that recognise the need for the critical thinker to move between the external world of discourse, and the internal world of the thinker's mind (Garrison, 1991). Further useful conceptualisations distinguish the characteristics of these two phases of critical thinking (Brookfield, 1987; Garrison, 1991, 1992), illustrated in Table 3.5: successive encounters with the external world are represented by the white rows; the internal world is represented by the turquoise row.

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Table 3.5.: Alignment of various conceptualisations of critical thinking.

Dewey's 'reflective thinking' (1933)	Brookfield (1987)	Garrison's 5 stages (1991)	Garrison's incorporation of creative thinking	Garrison's cycle of 'reflection' and 'discourse'	Garrison's 'internal and external worlds'	Lipman's 'higher-order' thinking'	'Cognitive Presence' component of Garrison *et al's* CoI Framework (2000)	'Cognitive presence' component of adapted CoI Framework (see 3.4.1).
Problem	Identifying assumptions	Problem identification	Justification	Discourse	External (with others)	Critical & caring thinking	Trigger	Trigger
Intellectual-isation of problem		Description					Exploration	External exploration
Reviewing possible solutions	Imagining alternatives	Exploration	Discovery/ Creativity	Reflection	Internal (one's private thoughts)	Creative thinking		Internal exploration
Mental elaboration		Applicability					Integration	Integration
Verification (testing favoured hypothesis)	Identifying assumptions	Integration	Justification	Discourse	External	Critical & caring thinking	Resolution	Resolution

Building on Table 3.3, this table illustrates how we may align five-stage conceptualisations of reflective (Dewey, 1933) or critical (Garrison 1991) thinking with biphasic conceptualisations of critical thinking (Brookfield, 1987; Garrison, 1991, 1992); and with the cognitive presence element of Garrison et al's (2000, p.89) CoI Framework, and my adaptation of this. The white rows represent cognitive activity in the social world; the turquoise represents cognitive activity in the mind of the individual.

3.4.1 My adaptation of the CoI Framework

To further understand the nature of the thinking in the two phases, we can align the five stages of reflective (Dewey, 1933) or critical (Garrison, 1991) thinking (Table 3.5, first and third columns). This is also useful in understanding how the CoI Framework (Garrison *et al*, 2000) relates to previous ideas about critical thinking. Garrison *et al* (2000) amalgamated Garrison's (1991) problem description and problem exploration into a single stage, or category: namely exploration. They said this was exemplified by information exchange, which implies that they saw exploration as a feature of the external world. Yet exploration would surely also apply to the creative aspect of critical thinking, where the thinker comes up with possible solutions or hypotheses. In any framework that builds on socio-constructivist theory, where one is especially interested in the contribution of discourse, it seems important to distinguish those aspects of critical thinking occurring in the internal world, from those occurring in the external world. Thus my conceptualisation of critical thinking in a PBL context (Tables 3.5, last column; Table 3.6) requires adaptation of the CoI Framework, with the exploration category of cognitive presence (Garrison *et al*, 2000) split into external and internal exploration, respectively referring to problem exploration in the external and internal worlds.

Note that in the CoI Framework, and my adaptation, integration takes place in the internal world and refers to the thinker effectively trying out possible solutions or ideas to enhance his existing understanding of the problematic concept, to arrive at a favoured solution; this is distinct from the integration stage of Garrison's (1991) five-stage model, which is akin to resolution in the CoI Framework and is more about integrating the favoured solution into the external world, by application of the new understanding, or reflection on its consequences. Resolution encapsulates the articulation and testing of the new understanding, via discourse or - outwith the PBL context - via the written word. The adapted CoI Framework is anticipated to allow identification of cognitive presence, or critical thinking, in a PBL context.

I am also interested in factors within the PBL tutorial that may impact on critical thinking, such as social interactions amongst the students, input from the facilitator (Katz, 1996; Wilkie, 2000, 2004), the PBL process, and/or the specific clinical problem presented to the students. These factors relate to the social presence and teaching presence elements of the CoI Framework (Garrison *et al*, 2000). The original categories for social presence seemed relevant to the PBL context and were retained. However, the categories for teaching presence were established in the context of research into online learning environments, where the teacher may have a more directive role than would be expected of PBL facilitators. Moreover, the categories used by Garrison *et al* (2000), and by Anderson *et al* (2001) amalgamate the process and materials aspects of instruction design and organisation, whereas I am specifically interested in the respective contributions of the structure afforded by the PBL process; and resources, such as the PBL scenario.

Thus in my adaptation of the CoI Framework, teaching presence is divided into six categories (Table 3.6): four of these relate to soft scaffolding (Saye & Brush, 2002) and include facilitation of the PBL process, facilitation of understanding, and facilitation of development, as well as directive input; the other two categories, resource and structure, relate to hard scaffolding (*ibid*.). Importantly, my conceptual framework allows for the possibility that soft scaffolding teaching presence could be provided by students, as well as the facilitator. Conversely, social presence could be attributed to the facilitator as well as the student members of the community, a possibility recognised by Swan and Shih (2005).

In summary, Table 3.6 presents an adapted CoI Framework, consistent with a socio-constructivist perspective and tailored to investigating critical thinking in the social context of a PBL tutorial.

Table 3.6.: An adapted CoI Framework for the analysis of PBL discourses, to demonstrate critical thinking and the factors affecting this.	
Cognitive presence	Trigger
	Exploration - external
	Exploration - internal
	Integration – of possible solutions with problem
	Resolution – incorporating and testing favoured solution
Social presence	Emotional expression
	Open communication (risk-free)
	Group cohesion
Teaching presence	Facilitating process
	Facilitating understanding
	Facilitating development
	Directive
	Structure
	Resource
The table illustrates how the original CoI Framework of Garrison et al (2000, p89) has been adapted to apply to the context of the PBL tutorial in the featured medical curriculum. The main text (3.4.1) provides the rationale for the additional categories in the cognitive and teaching presence elements.	

Chapter 4. Evidence for critical thinking in PBL-based/containing medical curricula, and why this matters.

This brief Chapter returns to the intended learning outcomes (ILOs) of problem-based learning (PBL) and considers whether PBL meets the ILO of promoting critical thinking by medical students (Maudsley & Strivens, 2000a, 2000b), and why this matters.

4.1. Critical thinking as an intended learning outcome of tertiary education.

The preceding chapter described various conceptualisations of critical thinking, across and within disciplines. Whilst there is disparity in what educators mean when they talk about critical thinking, they do seem to agree that graduates should be able to think critically (Banning, 2005; Lampert, 2007). Traditionally, at least in western cultures (Barnett, 1997), critical thinking has been mostly associated with university education. The Scottish Credit and Qualifications Framework [SCQF] (2012) specifies generic ILOs expected at different levels of education. Critical thinking underpins many of the cognitive abilities expected of Scottish students at SCQF levels 8 (Higher National Diploma) to 12 (doctoral study).

4.2. Critical thinking as an explicit intended learning outcome of medical education.

Medical curricula are expected to foster critical thinking ability (Barrows, 1988; Maudsley & Strivens, 2000a; 2000b). Subject-specific benchmarks for medicine include critical thinking, or related cognitive activities. Critical thinking is a level 3 outcome in The Scottish Doctor (The Scottish Deans' Medical Curriculum Group [SDMCG], 2011), a general curriculum for Scottish medical schools, which is closely aligned with Tomorrow's Doctors 3 (General Medical Council [GMC], 2009), a curriculum for all UK medical schools. This latter does not make explicit mention of critical thinking, but benchmarks include related cognitive abilities, such as critical appraisal. In a report

produced in response to the Quality Assurance Agency's Enhancement Theme on Research-Teaching-Linkages, Struthers, Laidlaw, Aiton, Humphris and Guild (2008) provided evidence from interviews and symposium discussion groups that medical educators and practitioners view critical appraisal as an essential skill for their students.

Critical thinking is regarded as fundamental in medical education because it is held to underpin key professional skills: clinical reasoning, clinical judgement and decision-making (SDMCG, 2011). Clinical reasoning has been discussed earlier (see 3.3.1) and will not be considered further. Judgement has been defined (see 3.3.1) as the deliberate choosing of one favourably-evaluated option over another; clinical judgement would be exercised in relation to patient care. Clinical decision-making may be regarded as the process of coming to a clinical judgment, of deciding between alternative courses of action in relation to patient care. The traditional model of clinical decision-making was paternalistic (Frosch & Kaplan, 1999; Weston, 2001) and failed to take account of the patient's perspective. This is no longer viable, given new standards of informed consent and an increasingly educated, sceptical public (Frosch & Kaplan, 1999). A newer model is shared decision-making [SDM] (Chisholm, Cairncross & Askham, 2006), in which the doctor helps the patient to see the extent to which different health management options and their consequences match with the patient's preferences and goals. This requires the doctor to consider and present alternative options and to consider the patient's perspective, consistent with Paul's (1995) strong-sense critical thinking (see 3.3.3) and Lipman's (1995) notion of caring thinking (see 3.3.9).

Despite its importance in underpinning medical practice, critical thinking is seldom defined by medical educators; nor are they explicit about how medical students develop this ability. Educators may assume that critical thinking is a by-product of a science-based education, but even if that were so, today's medical students spend relatively less time applying the scientific method and arguably more time absorbing information. Maudsley and Strivens (2000b) said that 'brainstorming … encourages divergent thinking … [which is] … best learned and applied in groups' (p.540). Drawing on

Abercrombie and Brookfield, they argued (*ibid*.) the potential for group learning to foster critical thinking. They noted that Barrows and Tamblyn (1980) based their model of PBL on hypothetico-deductive reasoning which, as discussed in 3.3.1, is a cognitive activity associated with critical thinking. This association of PBL with clinical reasoning likely perpetuated the belief that PBL promotes critical thinking.

4.3. Evidence for critical thinking in PBL-based/containing medical curricula.

However, at the outset of this study, in 2006, there was little empirical evidence that PBL promoted critical thinking by medical students. The number of relevant articles has increased, although relatively few relate to the medical education context. In May 2014, a search of the Pubmed database for *critical thinking* plus *problem-based* plus *medical* gave 96 hits. However, these included reviews (Harasym, Tsai & Hemmati, 2008) and studies in other health professions. In the interests of space and applicability, this critique focuses mainly on empirical studies in PBL-based/containing medical curricula.

4.3.1. Perception studies.

In surveys, Swedish medical undergraduates (Birgegard & Lindquist, 1998) and graduates (Antepohl *et al*, 2003) believed that PBL encouraged and developed critical thinking. Second year Chinese medical students randomised to a hybrid-PBL course reportedly found this had a positive effect on their critical thinking (Lian & He, 2013). Shafi, Quadri, Ahmed, Mahmud and Iqbal (2010) investigated the perceptions of students and staff regarding a second-year renal module in a systems-based, integrated Pakistani curriculum. Forty-four percent of student respondents 'believed that critical analysis of the data was encouraged during … small-group sessions' (*ibid*., p.17), whilst 65% of staff agreed that 'small-group discussions promoted more critical thinking by the students' (*ibid*., p.18), but the module included PBL and small-group case-based discussion, and it is not clear whether only one of these or both were perceived as promoting critical thinking. Finally, first-year students at Harvard Medical School in the

U.S.A. were randomly assigned to tutorial groups, some of which used concept maps; just under 60% of students in groups using concept maps agreed these helped them to think critically about cases (Veronese, Richards, Pernar, Sullivan & Schwartzstein, 2103). This was supported by open text responses, which indicated that concept maps helped students integrate knowledge and develop hypotheses, consistent with earlier conceptualisations of critical thinking (Chapter 3).

These studies each have their own strengths and limitations, but common to all is the issue that they clearly mean different things by the term, PBL (Maudsley, 1999). Moreover, we do not know what the respondents in each study defined as critical thinking. Finally, as with all perception studies, we do not know whether perception corresponded with actual student performance.

4.3.2. Quantitative instruments to measure critical thinking disposition or ability.

Some researchers have measured students' critical thinking disposition or ability using, respectively, the California Critical Thinking Disposition Inventory (CCTDI; Facione, Facione & Sanchez, 1994) or the 80-item Watson-Glaser Critical Thinking Assessment (WGCTA) test (Watson & Glaser, 1980). At the outset of the research described in this thesis, two studies were identified in which the authors had used the WGCTA test to investigate the critical thinking ability of students in an American medical school, before and after the intervention of the traditional pre-clinical curriculum (Scott & Markert, 1994; Scott, Markert & Dunn, 1998). A May 2014 search of the Pubmed database for *critical thinking* plus *medical* plus *WGCTA*, revealed one additional study with pre-clinical Iranian medical (and dental) students (Mahmoodabad, Nadrian & Nahangi , 2012), although in this case the authors only assessed students' critical thinking ability at the beginning of their course, and discussed the implications of the low average scores. However, none of these studies featured PBL-based/containing curricula, so they are of limited interest in this thesis.

4.3.3. Content analysis to assess critical thinking in PBL discourses.

Various groups have used content analysis to investigate whether critical thinking takes place during the PBL tutorial. This is a quasi-quantitative method, in which the researcher codes text to specific categories of meaning, then calculates the frequency with which each category is utilised. Content analysis has been used to look for indicators of critical thinking in face-to-face PBL tutorials (Kamin, O'Sullivan, Younger & Deterding, 2001; Kamin, O'Sullivan, Deterding & Younger, 2003; Basu Roy & McMahon, 2012) and webinars (Takata, Stein, Endo, Arai, Kohsaka, Kitano, Honda, Kitazano, Tokunaga, Tokuda, Obika, Miyosho, Kataoka & Terasawa, 2013).

Kamin *et al* (2001) refined a coding scheme developed by a Belfast group (Newman, Webb & Cochrane, 1995) studying computer-mediated-communication. This coding scheme was based on Garrison's (1991) five stages of critical thinking, with indicators corresponding to in-depth or surface learning, the former being associated with critical thinking. The researchers calculated the ratio of deep-to-surface indicators (Newman *et al*, 1995) to measure the degree of critical thinking within and across Garrison's five stages. Using this method, Kamin *et al* (2001) examined the effect of text versus video case modality on critical thinking by third-year students in a North American PBL-based medical curriculum. For the problem identification and problem description stages of critical thinking (Garrison, *op.cit*), equivalent to the trigger and external exploration categories in my adapted CoI framework (see 3.4), the group presented with a text case had a higher critical thinking ratio (CTR) than the group presented with a video case; but across the five stages, the group presented with the video case had a slightly higher CTR. The authors acknowledged that the findings could reflect differences in the critical thinking ability of each group, rather than case modality. However, they offered logical explanations as to why differences in the CTR might genuinely reflect case modality: for example, students presented with a video case had to gather information about the paediatric problem from the physical cues of the baby and the body language of the mother, which could make it more difficult to identify and describe the problem.

Possibly, the more challenging nature of the video presentation could have encouraged the creative component of critical thinking (Newell *et al*, 1958), thereby contributing to the higher CTR.

Kamin *et al* (2003) later compared the effect of text, video, or virtual case modalities on critical thinking. They conducted this study on a larger scale, with four or five PBL groups per case modality, which allowed them to perform statistical analysis on the data. However, they set the level of significance at $P<0.1$, which means they accepted a 1-in-10 chance of wrongly concluding that a significant difference existed (Clegg, 1990), which potentially exaggerated the significance of their data. They claimed that video presentation of cases enhanced critical thinking, consistent with their earlier study; and that students in a virtual PBL group (webinar) showed more critical thinking than students in the face-to-face groups, which they explained on the basis that members of virtual PBL groups might feel a greater sense of accountability, might have more time to reflect and formulate their postings; and/or virtual PBL might allow the individual more control over his learning, viewing or reviewing the case as often as desired.

Using the same coding scheme in a cross-over study design, Basu Roy and McMahon (2012) investigated the impact of text versus video case modality on critical thinking by second-year students at Harvard Medical School. Regardless of modality, problem description accounted for 28% of utterances, with problem exploration accounting for 50% (*ibid*.); these respectively equate to the external and internal exploration stages of my adapted CoI Framework (see 3.4). However, students presented with cases in the video format showed less critical thinking than those presented with text-based cases, and this was especially notable during problem exploration (Basu Roy and McMahon, 2012). This conflicted with Kamin *et al* (2001, 2003), but was explained on the basis that the patients in Basu Roy and McMahon's (2012) video cases had no physical signs, making the problem especially challenging. One might have expected this would enhance the creative exploration stage (Newell et al, 1958), but possibly their lack of clinical knowledge meant the challenge was too great for second-year medical students.

Finally, Takata *et al* (2013) analysed discourses from four webinar sessions, which they described as 'PBL structured tutoring sessions' (*ibid.,* p.156). Perhaps significantly, tutors were described as instructors; and students' contributions were described as responses. Takata *et al* (2013) claimed to use a modification of the Practical Inquiry Model (Garrison *et al*, 2001; see 3.3.10); however, they modified it almost out of recognition. They generated seven 'critical thinking response types' (Takata *et al*, 2013, p.157), three of which were subsequently conflated as 'simple response types' (*ibid.*, p158) which together accounted for 85% of student responses. However, two of these conflated response types were broadly equivalent to external and internal exploration in my CoI framework (see 3.4), whilst the third related to social commentary, which in fact signified social presence. So the authors did not properly engage with the CoI Framework or appreciate the significance of its different elements.

4.3.4. Corpus linguistic analysis to identify critical thinking during PBL discourse.

Da Silva and Dennick (2010) utilised corpus linguistic analysis to identify and quantify the use of technical terminology, semantic categories (anatomy/physiology, disease, or medicines/treatment; change/causality or probability), subordinating conjunctions such as *because* and *although*, and questioning words (*ibid*., p.284) such as *what* or *why*, during a three-session cycle of a PBL case in an English graduate-entry medical school. In session 1 students brainstormed and set objectives; in session 2 they shared answers; and in session 3 they integrated their new knowledge constructions with further clinical data. The relative frequency and type of technical terminology, semantic categories, subordinating conjunctions and questioning words used in any one session were consistent with the purpose of that session. A limitation of the study was that the facilitator's contributions were not distinguished from students', although it was argued they were likely to constitute just a small proportion of the total. Assuming this to be the case, the findings were consistent with students demonstrating actual critical thinking during PBL discourse.

4.4. Rationale for the study; aims and research questions.

From section 4.3, there is limited evidence to support the contention that PBL-based/containing curricula promote critical thinking ability in medical students. Perception studies do not tell us whether critical thinking actually takes place; tools such as the WGCTA test do not inform us about which aspect of the curriculum fosters critical thinking; so the evidence is limited to the four content analysis studies and the single corpus linguistics study critiqued above. Other than Basu Roy and McMahon (2012), who utilised cognitive load theory, the researchers were not explicit about their theoretical framework; and none of the studies specifically addressed the contribution of social interactions by PBL group members, or of their facilitator.

So it seemed there was scope for taking a socio-constructivist perspective; applying Lipman's Community of Inquiry [CoI] construct (Lipman, 1988, 2003) in the social context of a PBL tutorial; and using an adaptation of Garrison's CoI Framework (Garrison *et al* 2000), to address whether critical thinking is in evidence during PBL tutorials in the early years of a Scottish medical curriculum, and to draw conclusions about the extent to which specific aspects of the PBL CoI might enable or impede critical thinking.

4.4.1. Aims.

My aims in carrying out this study were three-fold:

1. To develop a relevant conceptual framework for critical thinking in the context of a PBL tutorial;
2. By applying this framework, to seek evidence for critical thinking during PBL discourses in the early years of a Scottish medical curriculum; and
3. By applying this framework, to identify factors that enabled or impeded critical thinking in this context.

The development of my conceptual framework was described in Chapter 3, with specific details of the adapted Community of Inquiry Framework presented in section 3.4.1 and in Table 3.6. In relation to my second and third aims, I conducted an empirical study to address the research questions outlined below.

4.4.2. Research Questions.

The specific research questions were:

1. To what extent is cognitive presence (a proxy for critical thinking) demonstrated by students participating in PBL tutorials in the early years of a Scottish medical curriculum?
2. To what extent are social presence and teaching presence in evidence during PBL tutorials, in this context?
3. What interactions exist between the different elements identified using an adapted Community of Inquiry Framework, and what does this tell us about enablers of, and impediments to critical thinking?

The following chapters describe the design of the empirical study, my findings and my conclusions.

Chapter 5. Methodological approach and study design.

5.1. Introduction to Chapter.

This Chapter will describe the methodological approach adopted; briefly critique the appropriateness of various research methods to address the research questions specified in 4.4.2; and conclude with a description of the study design employed.

The methodological approach reflects the researcher's epistemological and ontological perspectives; respectively, these are his views on the nature of knowledge (see 2.2.1) and social reality. A major research paradigm is positivism, whose protagonists believe in one reality, which may be verified only by observation and experiment. Positivism is associated with the natural sciences; closely aligned to the scientific method; and associated with quantitative methodologies and methods, which involve 'the collection of data in numerical form' (Garwood, 2006, p.250). My early leanings towards positivism were a consequence of an early career in biomedical science, which entailed training in, and application of, the scientific method. This was tempered by a growing appreciation of the possibilities offered by other paradigms to answer social science research questions.

One such research paradigm is interpretivism (Cohen, Manion and Morrison, 2011), whose proponents believe that social reality is constructed by individuals. The interpretivist researcher is also a participant who helps to construct reality in the context of the specific piece of research, and who seeks explanations for that reality. Interpretivism is generally associated with qualitative methodologies and methods, which investigate 'the meanings and interpretation of social phenomena and social processes in the particular contexts in which they occur' (Sumner, 2006, pp.248-9).
An interpretivist approach was appropriate for this study, which aimed to investigate the social phenomenon of the PBL CoI and the impact of social processes, or discourse, on critical thinking.

Interpretivists focus on specific individuals, cases or instances, leading to the charge that their research is not generalisable. However, interpretivists may make qualified generalisations, or fuzzy generalisations (Bassey, 1999, 2001), which Bassey (2001) defined as statements 'that may be true' (p.10). Such qualified or fuzzy generalisations could suggest how practitioners might reconsider their practice, to bring about change in their own context (Pratt, 2003). Interpretivists tend to refer to the transferability of their research, which is its applicability to other contexts. This is similar to Pratt's interpretation of fuzzy generalisation.

5.2. Appropriate methods to address the specific research questions.

Although the interpretivist approach is generally associated with the qualitative paradigm, the researcher should choose methodologies/methods best-suited to answering his specific research questions. Note that methodology reflects the general approach, whereas methods are specific techniques consistent with that methodology. In designing research, it is necessary to consider appropriate methods for collecting data, but also for its analysis.

5.2.1. Data collection.

To address the first research question required (a) method(s) that could evidence critical thinking that was actually taking place during PBL tutorials in the featured curriculum. Questionnaires to measure perceptions of critical thinking (see 4.3.1) were not relevant, since they say nothing about actual performance; nor were aptitude tests such as the WGCTA test of critical thinking ability (see 4.3.2), since they are used for pre/post-testing and would say nothing about what was happening during the PBL discourse. We may infer what a participant is thinking, or has just been thinking, by what he says, and possibly by his non-verbal reactions (Carter *et al*, 2006). To address the first research question one possibility was therefore to capture the PBL discourse, by audio-recording and transcribing it, for analysis. Another option was to observe the tutorial, to analyse non-verbal communication. Direct observation, an ethnographical method, was not warranted for this study since

my presence might have perturbed the PBL CoI, especially given my insider status (Bennett, Foreman-Peck & Higgins, 1996; see 5.4.1). Indirect observation of video-recordings, or for that matter listening to audio-recordings, still carried the risk of a Hawthorne effect, which is where participants' behaviour is impacted by their awareness of being investigated. Since social and teaching presence would be indicated by certain forms of communication (Garrison *et al*, 2000) during the PBL tutorial, capturing the discourse would allow the second research question to be addressed. To answer the third question required interpretation of discourses. The most appropriate method for collecting data to answer all three research questions was therefore audio-recording and transcription of the discourses. Ultimately, video-recordings were also made, to allow identification of speakers and thereby ensure that contributions could be attributed correctly.

5.2.2. Data analysis.

Content analysis.

One possibility for analysing transcribed PBL discourses was content analysis. This method was originally used to analyse the content of newspapers and it became especially well developed in the 1940s (Scott, 2006). It aims to allocate, or code, data to distinct, non-overlapping categories of meaning. The researcher traditionally calculates the frequency with which he codes to particular categories, so content analysis has been described as quasi-quantitative (Flick, 2006). Content analysis of PBL discourses has previously been used to demonstrate critical thinking during PBL (Basu & Roy, 2012; Kamin *et al*, 2001, 2003; Takata, *et al*, 2013; see 4.4.3). However, as practised by these authors, it would not allow questions to be addressed regarding enablers of, or impediments to critical thinking. Moreover, as my conceptual framework developed, it became apparent that it would not be possible to develop non-overlapping categories of meaning, since individual utterances could reasonably be said to demonstrate different elements of my adapted CoI Framework (see 5.4.6).

Discourse analysis.

Discourse analysis is a generic term for several approaches that involve 'studying and analysing the use of language' (Hodges, Kuper & Reeves, 2008, p.570). Whereas content analysis focuses on quantification of specific words, discourse analysis looks at underlying meanings and/or the relationships between participants. Categories of discourse analysis include: formal linguistic discourse analysis, which focuses on semantics and structure; empirical discourse analysis, which includes conversation analysis and genre analysis, and which is concerned with 'sociological uses of language' (*ibid*., p.570); and critical discourse analysis (CDA), which is concerned 'not only [with] the examination of text and the social uses of language but … the ways in which the very existence of specific institutions and of roles for individuals to play are made possible by ways of thinking and speaking' (*ibid*.).

The corpus linguistics study by Da Silva and Dennick (2010), described in 4.3.4., exemplified the formal linguistic approach to discourse analysis. However, the quantification of technical terms, semantic indicators, subordinating conjunctions or questioning words, without any contextual information, was an acknowledged weakness of their approach (*ibid*.). Moreover, by analysing the PBL discourse as 'one global conversation' (*ibid*., p. 285), it was not possible to attribute words to a particular speaker; without this, one cannot make inferences about the impact of one contribution on another, so this approach would not be useful in addressing my research questions.

In contrast, conversation analysis, one form of empirical discourse analysis, is concerned with the sequential organisation of talk; with how one utterance is shaped by the preceding one and in turn helps to shape the following utterance, which would make it a suitable method for our purposes. However, as well as coding of text, conversation analysis requires due attention to pauses, tones and non-verbal communications. In this study, pauses and tones were identifiable using audio-recordings. Although video-recordings were also available, the practical set-up was

not helpful for identifying non-verbal communications, with only one camera trained on a group of eight students plus their facilitator.

Barrett (2010) used CDA to investigate postgraduate education students' understanding of the PBL process, but the method does not seem to have been applied to look for critical thinking during PBL tutorials. It could be useful in investigating issues such as power during the PBL discourse, but was not deemed especially relevant to address my research questions.

In the event, the method used for data analysis seems consistent with empirical discourse analysis, but it evolved from initial attempts to use content analysis. The method was termed interpretivist contextual analysis, which captures what was involved.

5.3. Evolution of the study design.

At the outset of this study, content analysis using a pre-existing, published coding scheme appealed, since this would potentially render the research findings more acceptable in my professional context. Biomedical scientists and most clinicians are trained within, and subscribe to, the positivist paradigm, so my professional colleagues would likely regard the use of a pre-existing, published coding scheme, and the consequent findings, as more valid: that is, more likely to be measuring the phenomenon under investigation.

Thus the coding scheme used by Kamin *et al* (2001) was piloted with a transcript from an old staff training video. The transcript was imported into NVIVO (8.0) and coded to Kamin's indicators of critical thinking; with some utterances coded to free nodes, representing new categories that emerged as coding proceeded. For a transcript representing thirty-five minutes of a PBL tutorial edited for training purposes, 544 utterances were mapped to 52 nodes, including Kamin's 35 indicators (*ibid*.). The number of additional nodes reflected the difficulty in allocating text to codes within Kamin's scheme. Moreover, as my conceptual framework developed, it

became apparent that Kamin's scheme was not appropriate for answering my research questions about the existence of social and teaching presence in PBL discourses; or about enablers of and impediments to critical thinking. Ultimately, data were analysed with a coding scheme based on my adaptation of the CoI Framework (see 3.4 and 5.4.5).

It also became apparent that content analysis *per se* was not appropriate. My concern in this study was to interpret any instances of critical thinking in context, to make inferences about factors that enabled or impaired critical thinking. Ultimately the method employed was termed interpretivist contextual analysis (see 5.2.2 and 5.4.6.).

5.4. The study design.

The remainder of this chapter describes the study design employed to answer the research questions in 4.4.2.

5.4.1. Access, ethical considerations and ethical approval.

At the outset, the proposed research was discussed with the then Head and Deputy of the featured medical school. There was broad agreement, subject to ethical approval. All research must be carried out in an ethical manner. Guidelines have been published by the British Educational Research Association (BERA, 2011) and the Scottish Education Research Association (SERA, 2005). The SERA guidelines are especially pertinent, since the research was conducted in Scotland. According to SERA (2005), researchers have an ethical responsibility to their participants; their sponsors and other stakeholders; to the field of education research; and to the community of education researchers. Ethical considerations are relevant at all stages of the research process, from study design to dissemination of the findings.

Since this study was conducted in my own place of employment, it constituted insider research (Bennett *et al*, 1996), in which the objectivity of the researcher cannot be taken for granted; although this concept is arguably less relevant in

interpretivist research. However, in my various professional roles (see 1.6) I had, and have, considerable contact with students in Years 1 and 2 of the featured curriculum; those very students from whom participants were recruited. As a PBL facilitator and a trainer of new PBL facilitators, I could also be said to have a vested interest in an outcome that was favourable for PBL. It was important to be aware of and acknowledge these potential biases and to evidence ethical conduct of the research by careful documentation of the research process, in a reflexive manner.

An application was submitted for ethical approval to the Research Ethics Committee (REC) at the University of Strathclyde; approval was granted on 13th February 2007 (Appendix A). My own institution, where the research was to be conducted, required only that a copy of Strathclyde's letter of approval be lodged with the host REC (Appendix B) and that they receive a report on the outcomes in due course. Note that the ethics application included aspects that were not pursued, due to difficulties with recruitment and in light of my developing conceptual framework.

Written informed consent was obtained from participants (Appendix C). Anonymity/confidentiality was ensured by using codes to identify PBL groups and individual participants in the transcripts of PBL discourses and in the subsequent reporting of the findings (including this thesis). Data protection was achieved by storing video-recordings and DVD copies of these in a locked filing cabinet and by storing audio-recordings and transcripts on password-protected PCs.

The data collection method, recording of PBL discourses, was minimally intrusive: students were filmed/recorded whilst taking part in one of their scheduled PBL tutorials, so they were not required to give additional time, other than an extra fifteen minutes for briefing prior to the tutorial.

SERA (2005) discourage the use of incentives and none were offered prior to the commencement of data collection. However, as a thank you to participants, I gave each student/facilitator a small bar of chocolate at the break between the two halves of the PBL tutorial. These thank you gestures were not regarded as unethical,

because participation was sought, consent given, and participation was underway before the gestures were made.

Obligations to the sponsors of this study (the relevant School of Medicine and its undergraduate medical school), to the medical profession and to the education research community were met by conducting the research in an ethical manner. Obligations to the education research community were also met by carrying out the research in an intellectually robust manner; findings have been presented at (inter)national conferences on general, professional and medical education, putting into practice the principle of validating one's thinking in the external world (Chapter 3). On completion of the study, remaining obligations with regard to dissemination will be met with reports to relevant committees, and by submission of the work for publication.

5.4.2. Participants.

Participants included four Year 1 PBL groups at the featured medical school in academic session 2007-8; and two Year 2 groups. Additionally, there were six facilitators, comprising two faculty scientists, one faculty clinician and three hourly-paid staff who were all retired scientists. Three facilitators were male, three female; they had varying degrees of experience in facilitation.

5.4.3. Recruitment.

I had expected that it might be difficult to recruit participants. Even if students were willing, it could not be assumed their PBL facilitator would be amenable to the idea, since some colleagues are anxious about anything that constitutes peer observation: a specific difficulty for insider research. PBL facilitators were therefore recruited by purposive sampling of staff known to be comfortable with peer observation, and fully conversant with the PBL process: these staff had previously allowed trainee facilitators to observe their facilitation of a PBL group. The study was explained to these facilitators, to obtain their provisional, verbal consent. Each facilitator was

asked to explain the study to his/her PBL group; to distribute to each student a letter of invitation (Appendix D), an information sheet (Appendix E) and a consent form (Appendix C); and to ask them to give their responses at the next PBL session by placing their consent form, signed or blank, in a large envelope. Equivalent documentation was given to the facilitators to complete. If written consent was obtained from all students in a group and their facilitator, a video-recording was made of one of their subsequent PBL sessions. It was necessary to gain the informed consent of all eight students in each PBL group; any one student had the right of veto. However, this situation did not arise and 100% of those approached were recruited.

It could be argued that recruitment of students via their facilitator constituted soft coercion, but since students placed their consent forms in an envelope, and had the option to leave the forms blank, only I would have known which if any had vetoed the research. Moreover, the original intention had been to recruit just four PBL groups, two each from Years 1 and 2, but once the filming had begun, students' interest was aroused and other groups expressed an interest in participating. This presented an opportunity to collect additional data. Nevertheless, the described procedure was followed, resulting in recruitment of two more Year 1 PBL groups.

5.4.4. Data collection.

Audio-recording and video-recording equipment was set up in a PBL room with assistance of support staff from the institution's Learning and Teaching Centre. I met with each participating PBL group and their facilitator fifteen minutes prior to a standard, timetabled PBL tutorial. I explained that the PBL session should be conducted as usual and that both halves of the PBL tutorial would be recorded, to facilitate the search for evidence of critical thinking during all stages of the PBL process. I was not present during the filming, to minimise any inhibition on the part of the participants, but an audiovisual technician was contactable by phone, in the event of problems arising during the recording: none did. I showed the facilitators

how to operate the tape recorder and arranged to switch video-recordings at a specific time between the two halves of the tutorial.

Data collection took place in April/May 2008. Recording of PBL discourses was not piloted because of the anticipated difficulties in recruiting PBL groups. However, an existing video used for staff training was used to practise transcribing (see 5.3) and data analysis. Video-recordings of PBL tutorials were transferred to DVD by IT staff for ease of use, and the recordings and DVDs were stored securely (see 5.4.1). Audio (WMA) files were stored on password-protected PCs, and on a USB stick as back-up. Funding became available for transcription, so all audio-recordings, or the video-recording for one half of a tutorial where the tape recorder was not switched on, were sent for transcription to 1st Secretarial Services in Midlothian, Scotland. Since some of the terminology was unfamiliar to their staff, I sent a list of specialist terminology likely to come up in each discourse, based on the crib notes given to PBL facilitators. All transcripts were reviewed to correct for obvious typos, such as *interlocking* instead of *interleukin*. Transcripts were also reviewed in conjunction with the videos, to identify individual speakers where possible, although in some instances participants spoke so quickly, or talked over one another to such an extent, that individuals could not be identified.

5.4.5. Coding scheme: An adapted Community of Inquiry (CoI) Framework.

As described in Chapter 3, a socio-constructivist perspective on critical thinking was especially relevant in the context of this research; specifically the socio-constructivist concept of a community of inquiry (CoI). Garrison *et al*'s (2000) CoI Framework (see 3.3.10) was adapted to generate a coding scheme (3.4; Table 3.6) with three elements - cognitive, social and teaching presence - which respectively had five, three and six categories. The coding scheme evolved in an iterative process as data analysis progressed, with new indicators being added to each category (see Chapters 6 and 7). The final coding scheme is presented in Appendix F, including descriptors for indicators.

Cognitive presence/critical thinking.

As described in section 3.4, my adaptation of the CoI Framework included five categories of cognitive presence, a proxy for critical thinking (Table 3.6): trigger, external exploration, internal exploration, integration and resolution. A large number of indicators were generated to distinguish between sometimes subtle variations in utterances. For example, within the critical thinking category of integration, indicators included:

- Linking ideas
- Relating to previous PBL scenario or part of the course
- Relating to question raised by peer
- Relating to previous comment by peer
- Linking to previous experience outwith the course
- Relating to empirical evidence

In each case, the utterances indicated that the participant was recalling previous input from another individual or from an earlier experience and was integrating this with his thinking on the matter at hand. It was not thought to be problematic to have so many indicators. Indeed, Garrison *et al* (2000) likely used more indicators than they reported, since they stated that the indicators in their published coding scheme were examples. In this study, the use of multiple indicators made it easier to have confidence in coding utterances to a specific category of cognitive presence, but it was anticipated that for the purposes of reporting the findings, the emphasis would be on categories, since this would allow a sufficiently detailed analysis and comparison with previous work in which the CoI Framework was applied.

Social presence.

The three categories of social presence in Garrison *et al*'s (2000) CoI Framework were useful in the present study. These were emotional expression, open communication and group cohesion. The original indicators were retained, but additional ones created. For example, in coding to the category of emotional

expression, new indicators included *humour*, to code jokes; *laughter*; and *personal perspective*, to code utterances in which the participant talked about liking or disliking something.

Teaching presence.

Teaching presence was the element where most change was made to the original CoI Framework. This reflected the different style and purpose of the learning opportunity that was being investigated as the forum for critical thinking to take place. Here, the focus was on the PBL tutorial, whereas Garrison *et al* (2000) developed their CoI Framework in the context of asynchronous online tutorials. Although those authors applied the original framework in face-to-face settings (Vaughan, 2010; Vaughan & Garrison, 2005) these were tutor-led small group teaching sessions, which would likely be less learner-centred and more structured than PBL. Garrison *et al*'s (2000) categories of instructional management, building understanding and direct instruction were replaced with the following categories:

- Directive (similar to direct instruction)
- Facilitating process
- Facilitating understanding
- Facilitating development (of students)
- Structure (references to PBL process)
- Resource (within PBL - for example the scenario; or outwith PBL - for example, supporting lectures)

Utterances by student participants as well as those by the facilitator could be coded to teaching presence, since potentially the chair or other group members could facilitate the PBL process or facilitate their peers' understanding. Indeed, taking a socio-constructivist perspective, we should expect student participants to facilitate one another's understanding.

Negative aspects of social or teaching presence.

One further adaptation of Garrison *et al*'s (2000) CoI Framework was to recognise that indicators of social presence or teaching presence would not necessarily correlate positively with critical thinking by students in a PBL tutorial. It was conceivable that some social interactions could enhance the social environment without necessarily facilitating critical thinking by students (Swan & Shih, 2005), and some social interactions could potentially inhibit critical thinking. Similarly, it was possible that teaching presence could interact negatively with cognitive presence. This study was conducted towards a professional doctorate and therefore should inform professional practice on how best to facilitate critical thinking by students in PBL tutorials. It was therefore important not only to identify facilitative interventions that could be emulated by others, but to identify missed opportunities to facilitate critical thinking or, worse, utterances that might inhibit critical thinking.

5.4.6. Coding Strategy.

Unit of coding.

Coding was done on the basis of utterances (=U), which were defined as individual contributions to the discourse, generally delineated by a change of topic, a new speaker, or a natural pause. Individual contributions ranged from short phrases to substantial chunks of text. Analysing data at the level of utterances was consistent with a socio-constructivist perspective: if interactions between group members facilitate critical thinking, it makes sense to look at what one participant says in response to, or following on from, the previous speaker. Although consecutive utterances were usually made by different participants, on occasion one participant paused then went on to elaborate or to add a new perspective. Since this could potentially offer evidence of the individual moving through phases of cognitive presence, it was thought useful to consider consecutive utterances by a single participant as separate contributions.

Contextual coding.

Again consistent with a socio-constructivist perspective, utterances were coded in context. They were considered in relation to preceding comments, which could allow identification of, for example, integration by relating an utterance to an earlier comment by a peer; and utterances were considered in relation to comments that followed, since their impact could allow one to infer - though never be certain of - the intention behind the utterance. In particular, facilitators' utterances were interpreted according to their impact on the discourse. For example, in a scenario about care of the elderly, the Facilitator added an anecdote:

> *I was in what was a mining community and because of the shift working of the miners everybody had their main meal at about 4.30, 4.45 because they came off, had their baths, went home, got changed and that was when their wives would have it ready for them and they find it really difficult when their meals on wheels van appears at 12.00 with their main meal because they're not used to eating at that time of day …*
>
> *Fac, Y1C3T1, U13.*

Note that Y1C3T1 is Year 1 Group C3, Transcript 1. It was difficult to know how to code U13. Was it an example of the Facilitator providing directive information, albeit in anecdotal form? Or if one considered the Facilitator also to be a community member, then it could be an example of integration since it related to a previous comment from student F1 in group Y1C3. However, the Facilitator is likely to have some degree of expertise on the topic and cannot be considered equivalent to a regular CoI member. An alternative approach was to consider the impact of U13 on what followed. In fact, the Chair may have interpreted U13 as a signal that the line of discussion should be brought to a close, for he tried to move the group on to the next objective, but the Facilitator seemingly took control again by saying:

Can I ask a question?

Fac, Y1C3T1, U15.

This was coded as facilitating process, since the facilitator was effectively pulling the students back to the previous discussion topic. If the Chair inappropriately saw U13 as a signal to close an unfinished line of discussion, this might mean U13 was a negative indicator for teaching presence. Ultimately, though, it was decided to code utterance 13 to a new indicator, facilitating development by giving support, since the Facilitator's story supported an earlier idea put forward by F1.

A further example of contextual coding was when this same Facilitator went on to facilitate understanding, by asking a probing question:

Why do the government get it all so wrong …, because … you said … [care in the community] … cost more than it should have done.

Fac, Y1C3T1, U16.

This was followed by a lengthy discourse amongst the students, with examples of internal exploration and the integration category of critical thinking, which together constitute the creative component of critical thinking.

In some instances where a participant gave a relatively lengthy, articulate account of a topic, without hesitating and creating a natural pause, this was recorded as a single utterance. Where a qualitative difference was perceived in different parts of an utterance, these parts were coded separately. For example, in defining community care in the context of the scenario about care of the elderly, one participant said:

… community care means providing the right level of intervention and support to enable people to achieve maximum independence and control over their own lives. So it's like formal care which is by paid professionals and informal which is by relatives, and the main principle behind community care is allowing … disabled people to

remain within the community as long as possible. The key principles are enabling people to live in as normal [an] environment as possible, like homely environment, providing them with the ability to lead their own lives, like the services are provided to suit the individuals' needs and there is support given for carers and promoting quality assurance in shifting balance from a hospital setting to a community base.

M1, Y1C3T1, U6.

Most of this utterance seemed to be straightforward exchange of recalled information, placing it in the external exploration category of critical thinking. However, the solid underlined sentence was qualitatively different. It seemed as if M1 was expressing his own understanding, his own construction of knowledge, rather than re-iterating some author's construction. It was more creative than the preceding information and could have been taken as evidence of M1 having integrated knowledge into a new personal construction. One possibility was therefore to generate a relevant code and place this utterance in the integration category of critical thinking. However, the intention in this study was to code critical thinking that took place during the PBL tutorial, not to make inferences about critical thinking that may have taken place outwith the tutorial. Interpreting the underlined statement in the context of the tutorial itself, it was considered exemplification of the definition of community care. In addition, the phrases with dashed underlining were respectively considered exemplification of a normal environment, and of how community care might 'provide [people] with the ability to lead their own lives' (M1, Y1C3T1, U6). Exemplification seems to fit best with the critical thinking category of internal exploration, which incorporates various indicators that illustrate creative thinking on the part of the participant during the tutorial: hypothesis formation, providing explanations, offering suggestions/alternatives, and - here - offering examples.

Sometimes it was appropriate to code a whole utterance to more than one category. For example, in the same tutorial, a student participant was describing the management of dementia:

> *I got that the treatment can be divided into non-pharmacological and pharmacological and in terms of the non-pharmacological there's … conflicting management, there's things like reality or in patient therapy and it's continually reminding someone where they are; … every time you have direct contact tell them, get them to know the dates and where they are and … the surrounding environment. But there's also something called validation therapy which is more to do with focusing on the patient's self esteem and supporting their feelings in whatever time and place is real to them even if it's not real to you.*
>
> *F1, Y1C3T1, U84.*

This utterance could potentially be coded in four ways:

- Relaying information about forms of management;
- Relating to a previous comment by peer - namely 'management is really just being supportive because there isn't really much they can do' (U83);
- Connecting ideas - two different perspectives on non-pharmacological therapy for dementia - namely, reality or validation therapy; and
- Facilitating understanding by identifying conflicting information - in this case, conflicting ideas about the best way to manage dementia .

Note that the identification of conflicting information was interpreted to be teaching presence via facilitating understanding of the management of dementia, since it showed this to be a complex area, with competing theories.

Garrison *et al* (2000, 2001) interpreted the different categories of critical thinking in a hierarchical fashion, with trigger being the lowest, through to resolution being the highest. They coded each utterance to the highest legitimate category. They would

therefore have coded U84 as an example of integration. However, these authors used the CoI Framework for content analysis and they were concerned with quantifying instances of the different categories of critical thinking, which did not apply in this study. Moreover, the above example illustrates that single utterances could arguably be coded to different elements within the CoI Framework; in this case, to cognitive presence/critical thinking and also to teaching presence. From a CoI perspective, one cannot say that either construct takes precedence over the other. Thus in the context of this study, it seemed necessary to allow for individual utterances to be coded to multiple categories. Conversely, it was not deemed necessary to ensure that every piece of text was coded. There was no intention to undertake thematic analysis, therefore no need for saturation of the data to identify all possible themes.

5.4.7. Practicalities.

Coding was initially performed using NVIVO (8.0) software. However, this offered little advantage over manually entering codes into tabulations of utterances. Indicators of cognitive, social and teaching presence were highlighted on printed tabulations; the use of colour helped identify patterns where one element of the CoI Framework predominated, or where different elements were interspersed, suggestive of an interaction and worthy of close attention. For three transcripts, a duplicate table (Appendix G) of coded utterances was prepared, where each utterance was itself replaced with the justification for the coding decision. Comparison of duplicates allowed for review and amendment of coding decisions as necessary, and justification of these to supervisors. Having established confidence in the utility of the adapted CoI Framework and the integrity and consistency with which it was being employed, subsequent transcripts were coded without recourse to a duplicate.

5.5. Trustworthiness.

By the time the conceptual framework had been fully developed, and the coding scheme had been developed via an iterative process in parallel with data analysis, the student participants had moved into senior years and were not readily available to

undertake member-checking, that is, to review and comment on the findings. However, from an interpretivist perspective it is arguable whether it is truly necessary or appropriate to ask participants to verify the researcher's interpretation (Sandelowski, 1993, 2002). Trustworthiness has been established by other means (Carlson, 2010), including reflexivity, and thick and rich description of the data collection, analysis, interpretation and conclusions. The trustworthiness of the data collection and analysis has been addressed by the detailed account of the study design, above. The trustworthiness of the interpretation and conclusions in the following chapters was ensured by:

- discussing various iterations of the coding scheme with my supervisors;
- tabulating the justifications for each coding decision for three transcripts (Appendix G);
- discussing these justifications with my supervisors;
- acknowledging alternative interpretations and justifying why they were less preferred, as appropriate.

Chapters 6 and 7 detail the analysis and interpretation of the data from individual discourses.

Chapter 6. Analysis and interpretation of PBL discourses featuring Group Y1C3.

The data analysis and interpretation is presented in Chapters 6 and 7. Chapter 6 focuses on two discourses featuring Year 1 PBL Group C3, Y1C3 (Appendix H), analysed using my adaptation of Garrison *et al*'s (2000) CoI Framework (see 3.4). The findings and preliminary discussion of these are interwoven; a critical discussion of themes arising across multiple scenarios will form Chapter 8. My interpretation of the discourses featuring Y1C3 is supported by detailed reporting of the elements, categories and indicators identified; by evidence in the form of specific utterances (=U); and by explanations for coding decisions. In Chapter 7, ten discourses featuring the five remaining PBL groups will be discussed in terms of the extent to which they compare with the Y1C3 discourses: whether they show similar or different aspects of the adapted CoI Framework; and similar or different interactions between elements of the Framework.

To aid the reader, for Chapters 6 and 7, categories are given in bold, whilst indicators are in italics. Appendix F gives the final iteration of the coding scheme, including descriptors. Participants' quotes are italicised to distinguish them from quotes taken from the literature. Sometimes punctuation or text in parenthesis is added to quotes, to make them easier to read. To allow the narrative to flow, specific utterances are sometimes discussed in terms of one particular category or indicator; however, the utterance, or parts of it, may well have been coded to other categories or indicators.

6.1. Overview.

The data analysis and interpretation begins with two discourses featuring PBL Group Y1C3, for the following reasons:

- these discourses were the first to be recorded and it seemed natural to analyse them first;

- the scenarios (Appendix H) featured topics that were potentially more familiar to non-specialists, which facilitated discussion about the use of the adapted CoI Framework with my supervisors and other educationalists, who may not have had medical knowledge;
- likewise, it was anticipated that it would be easier to explain the findings and the utility of the adapted CoI Framework in the context of the discourses with Group Y1C3.

The Y1C3 discourses took place during a two-hour PBL tutorial. Recall that the steps in the PBL process (1.3) are, in abbreviated form: (1) define terminology, (2) identify issues, (3) brainstorm, (4) formulate questions and (5) identify resources; then following independent research, (6) share answers and (7) reflect. Since each two-hour tutorial begins with students completing steps 6 and 7 for one scenario before moving on to steps 1 to 5 of the next, the data has been analysed and presented in this same chronological order.

6.2. Group Y1C3, Steps 6 &7 of scenario about care of the elderly.

In this discourse, Group Y1C3 shared their independently-researched answers to specific objectives on community care for the elderly; services available to support elderly people in the community; the impact of dementia on carers [of people with dementia]; treatment and management of dementia; and the role of the old-age psychiatrist.

6.2.1. Cognitive presence/critical thinking.

Categories of cognitive presence, equivalent to aspects of critical thinking, were demonstrated by students in this CoI. In particular, there was evidence of students engaging in **external exploration**, **internal exploration** and **integration**, and there were examples of **resolution**. There was no instance of the **trigger** category of critical

thinking, which is unsurprising, since the students were debriefing on their independent research to answer PBL objectives set in a previous session.

PBL Step 6: External exploration.

In step 6, where students shared answers to their learning objectives, there were many examples of **external exploration**, the information gathering/exchanging aspect of critical thinking. There were no instances of *seeking information from a resource*, consistent with the fact that students are not expected to consult resources during this step of the PBL process. Neither were there instances of *seeking clarification*. However, there were many examples of students *seeking information by asking questions* and of *information exchange*. Table 6.1 offers examples of utterances coded in this way.

Table 6.1.: Examples of utterances coded to the external exploration category of cognitive presence in PBL step 6 [group Y1C3, transcript 1].

Indicator	Utterance	By	Text
Seeking information by asking question	41	F3	Is it seventy or seventy five? [re. retirement age].
	129	M2	So what's the argument for waiting till [they're] moderate now? [re. timing of pharmacological intervention for patients with mild, moderate or severe dementia].
Information exchange	54	F4	Direct services include things like residential services, day services, and so on.
	168	M3	An old-age psychiatrist is responsible for everyone that's over sixty five …

PBL Step 6: Internal exploration.

Internal exploration, a creative aspect of critical thinking, was indicated by *hypothesis formation*, *providing explanations*, *offering alternatives/suggestions* and *offering*

examples. In deciding whether to code a creative utterance as an hypothesis or an explanation, consideration was given to whether the idea was presented as a possible solution, which was coded as *hypothesis formation*, or a likely solution, which was coded as tentative *explanation*. Thus the apparent certainty with which the participant spoke - the tone of the utterance - dictated how it was coded. For example, with regard to attitudes to elderly parents going into homes:

> *… if it's their mother or father then they might feel guilty since their parents looked after them when they were young and now they've … been abandoned in a home.*
>
> *M1, Y1C3T1, U159.*

This was coded as *hypothesis formation* based on the participant's use of 'might' (M1, U159), which indicates an absence of certainty. On the other hand, F4 was more forthright about one reason for being reluctant to put elderly parents in a home, and her contribution was coded as a tentative *explanation*:

> *Well, there's quite a lot of bad publicity about some of these nursing homes ... so it's not that surprising that people are hesitant to put their relatives in care.*
>
> *F4, Y1C3T1, U166.*

In this line of the discourse, M4 offered an *alternative perspective* regarding one's elderly relative going into a home:

> *The other side of that is that you're more in contact with other people … even in a residential care home or a nursing home you've got … other people who you can mingle with, socialise with, as opposed to if you were just at home and once or twice a day or*

maybe three times a day you've got somebody coming, I mean for the rest of the day you are just alone.

M4, Y1C3T1, U153.

The final indicator of **internal exploration** in this discourse was *offering examples*. By way of illustration, this statement exemplifies community care:

So it's … formal care which is by paid professionals and informal which is by relatives….

M1, Y1C3T1, U6.

PBL Step 6: Integration.

There were a great many examples of **integration**, the second creative aspect of critical thinking. Very often, there was integration of new information with a previous *comment by a peer*; or integration of an idea with information or an experience from another part of the medical *course*. For example, in discussing why community care had cost much more than the Government originally anticipated, in response to student F1 explaining this on the basis of the aging population, her peer said:

Because I think we were shown the other day there had been … three baby booms … in the past century, … the two postwar ones and then one … more recently so, … the proportion of elderly people is rising and obviously they're going to have to be cared for.

F4, Y1C3T1, U20.

In the text above, the solid underline indicates that F4 was integrating information by relating back to a previous lecture, whilst the text with the dashed underline indicates integration by relating back to her peer's comment. In the same line of discourse, M4 integrated different *ideas*:

> *But it's only because we are an aging population and people are living longer, … they are calling it increasing morbidity, so … the relative amount of people needing care in the hospital setting or … nursing care ….is more, so that is going to be more expensive as well, they didn't anticipate that, I guess.*
>
> *M4, Y1C3T1, U37.*

Thus he integrated the idea that people are living longer with the idea of increasing morbidity in aged populations, and he formed a conclusion, indicated by the dashed underline, that 'the relative [my emphasis] amount of people needing care in the hospital setting or ... nursing care … is more' (M4, U37). This conclusion led to the utterance being simultaneously coded to the **resolution** category, discussed below.

Less commonly, there were examples of **integration** by relating to previous *experience outwith the course*, or to *empirical evidence*. Examples are shown in Table 6.2, below.

Table 6.2.: Two indicators of the integration category of cognitive presence [group Y1C3, transcript 1].

Indicator	Utterance	By	Text
Relating to experience outwith the course	74	F3	They normally forget who you are … as well. I was watching The Notebook the other night. Have any of you seen that film? [relating to TV documentary about dementia].
Relating to empirical evidence	100	F3	… there was a trial, I think it was in 2000, the AD2000 trial … to do with Alzheimer's disease and it showed they really had not much of a different effect from giving the placebo but they do however, allow the patient to remain at home for some months …

PBL Step 6: Resolution.

The fifth category of cognitive presence in the adapted CoI framework is **resolution**. This is equivalent to the verification/justification aspect of critical thinking, where the thinker tests his new understanding by *application of new ideas* (Garrison *et al*, 2000) or by *reflection on the consequences of new understanding* (*ibid*)., in keeping with Dewey's (1933) reflective thinker (see 3.2.3). *Application of new ideas* was arguably seen in the context of discussing the retirement age relative to life span:

> *Yeah, but by the time we reach seventy, the life expectancy will be a hundred or something.*
>
> *M4, Y1C3T1, U50.*

Initially, this seemed like a throw-away remark, but from the audio recording, the student's tone suggested that he was genuinely *applying the idea* that retirement age is likely to continue rising. Also, in discussing the rationale for therapeutic drugs being used to prolong the period of moderate dementia rather than the period of mild dementia:

> *Why don't they make it so that you have … [the medication] when you've got mild and moderate [dementia] and then ... stop it when you've got severe?*
>
> *M4, Y1C3T1, U133.*

Although this was presented as a question, I would argue that the student had clearly *applied the idea* that anti-dementia drugs can only be administered for a finite time, and had concluded that it would be better to prolong the period when the patient is less severely affected.

With regard to *reflecting on the consequences of new understanding*, consider:

> *How could they have thought it would be cheaper to help people separately in their homes rather than, I know it's not very nice having everyone put together in one place, surely it would be cheaper with having everyone together in the same place?*
>
> *M3, Y1C3T1, U22.*

Based on the use of the word 'surely' (M3, U22), one could argue this is **internal exploration** manifest as *hypothesis generation*. However, it also demonstrates *reflection on the consequences* of care in the community, so this utterance was simultaneously coded as **resolution**. By acknowledging different perspectives on communal care of the elderly, denoted by solid and dashed underlining, M3 demonstrated multi-logical thinking (Paul, 1995; see 3.3.3).

Finally, in the context of talking about her great-grandmother's move into sheltered accommodation, one student *reflected on the consequences* of this in terms of loss of independence and a lack of familiar objects, versus increased safety:

> *… I think [for] a lot of old people it's important for them to have all their personal things around them and she couldn't fit all these things in, and I think she felt a little bit enclosed and that was a big deal for her, but she felt … safer in the fact that they've got pull cords on the wall if she falls or anything like that, and like you're saying, the warden checks through an intercom system in the house, … shouts through a couple of times a day how she's doing, and she felt safe that way, but I think their independence is lost and I think it is an important factor that she didn't have her own … furniture and lots of things around about her.*
>
> *F2, Y1C3T1, U150.*

PBL Step 7: External exploration and resolution.

In the brief reflection step of this PBL discourse, cognitive presence manifest predominantly as **external exploration**, as students *exchanged information* about resources. One utterance was coded to the *meta-cognition* indicator of the **resolution** category, since it appeared that M4 was demonstrating meta-cognitive experience (see 3.3.1):

> *I tried to use [the] Scambler [textbook] to find out about the impact of dementia on the carer and it was just so complicated I really didn't understand it.*
>
> *M4, Y1C3T2, U178.*

This was simultaneously coded as a negative example of teaching presence (see 6.2.3), as it represented a **missed opportunity** for the facilitator to encourage discussion about dealing with complicated information.

6.2.2. Social presence.

The discourse contained some evidence for all three categories of social presence as defined by Garrison *et al* (2000). This element of the CoI Framework was seen only in PBL step 6 and manifest primarily as **emotional expression**, indicated by *humour* or *laughter*. One example was where the Facilitator tried to support M2 by supplying the name of a service that was being described by that student: 'a befriending service' (Fac, U64). The student misunderstood and thought the Facilitator was asking if that was the name of the service. When the student commented that he 'couldn't remember the exact name' (M2, U65), this brought laughter from his peers. From the audio- and video-recordings, the laughter seemed good-natured, and M2 did not appear to mind. In fact, he later set himself up as the target of humour when his peers laughed in response to his description of previous work experience:

> *I used to help out in a nursing home, … I'd … [say]… we're going to do a crossword now and they …[would] curse … under their breath [laughter] because they wanted to watch Coronation Street or something …*
>
> *M2, Y1C3T1, U156.*

There was one example of **open communication** manifest as *risk-free expression*. In explaining the coding strategy (see 5.4.6), it was described how the Facilitator steered students back to a line of discussion from which they were about to move on. He asked a probing question which was followed by a lengthy exchange of explanatory and integrative comments. At the end of these, the Chair said:

> *Anything else, any more questions?!*
>
> *M1, Y1C3T1, U34.*

Clearly, this was a reference to the Facilitator prolonging discussion of the issue at hand; but the Chair's tone was jokey and M1 clearly expected his pointed remark would be taken in good part. The final category of social presence in Garrison *et al*'s (2000) CoI Framework, is **group cohesion**. One possible indicator for this is *peer support*. Students had to say explicitly what they agreed with for the utterance to be coded as peer support. For example, when M4 commented that withdrawing therapy from severely-demented patients would not be seen as 'the right thing to do' (M4, U135), F4 said:

> *Yeah, you mean condemning lives.*
>
> *F4, Y1C3T1, U136.*

This was seen as distinct from *seeking clarification* because it seemed clear from the words and the intonation on the audio-recording that F4 understood what M4 meant and was agreeing with his idea. Finally, there were examples of **group cohesion** via

encouraging collaboration, when the Chair acknowledged the rest of the group as he attempted to move the discussion on:

> *Okay, is everyone happy to move on?*
>
> *M1, Y1C3T1, U68.*

In this discourse, there was no evidence of social presence directly enabling or impeding cognitive presence.

6.2.3. Teaching presence.

In the work by Garrison *et al* (2000), teaching presence was generally related to activities on the part of faculty. In the context of the PBL tutorial, faculty was represented not only via soft scaffolding (Saye & Brush, 2002) by the Facilitator, but by hard scaffolding (*ibid.*) in the structure of the PBL process, and in the form of resources, such as the scenario. Moreover, students could and did contribute to soft scaffolding teaching presence. Furthermore, teaching presence was often found to impact directly on cognitive presence.

PBL Steps 6 & 7: Soft scaffolding - directive, facilitating development, understanding and process; negative manifestations.

In this discourse, the Facilitator's contribution to teaching presence mostly consisted of supplying information. Nevertheless, his contribution was regarded as largely facilitative, not directive. Of four comments that were initially considered **directive**, one was explicit *advice* that students should expand on the management of dementia:

> *A bit more about the drugs and why we're not using them, why we've been told not to use them …*
>
> *Fac, Y1C3T1, U119.*

Here, the Facilitator gave guidance rather than factual information. Where he did give factual information, one instance was a jokey comment about shampoo ingredients (U107); one was effectively correcting a student who said that dementia is always progressive, by pointing out (U141) that an exception is where dementia is a consequence of vitamin deficiency; and one lengthy utterance (U126) was about drug interactions, and the advantages of prolonging periods of sanity for patients with dementia, to allow them to sort out their financial and personal affairs. U126 and U141 were initially coded as **directive**, but on reflection it became clear that the Facilitator was picking up on previous contributions from students. So these two utterances were re-coded as **facilitating development**, under the new indicator of *providing support* by confirming students' thinking. Thus, provision of factual information was seen as facilitative if it confirmed or built on material contributed by students, even where the intervention was corrective in nature. The rationale was that in making such interventions, the Facilitator indirectly acknowledged students' contributions and gave implicit feedback on how well their understandings matched with what was generally accepted. Several other utterances were coded to **facilitating development**. For example, the Facilitator told an anecdote (U13) that built on an idea put forward by F1, in relation to the timing of meals-on-wheels services. Also, he answered (U36) his own earlier question about why community care cost so much more than had been expected, but only after many suggestions by students; thus he was subtly able to give the generally-accepted answer, whilst acknowledging that students' suggestions were appropriate.

Whilst **facilitating development** was where the Facilitator supplied factual information that was seen as supporting students' development, the category of **facilitating understanding** was where the Facilitator sought information about students' rationale for statements they made, or helped them to identify conflicting statements. There was only one example of this Facilitator exhibiting this behaviour, when he asked a probing question (U16), but this instance of soft scaffolding teaching presence clearly enabled aspects of critical thinking, since it was followed by a lengthy exchange of utterances

coded to the **internal exploration** and **integration** categories of cognitive presence. There were also examples of students **facilitating understanding** by *identifying conflicting information*. In response to F4 defining respite care as the temporary accommodation of elderly people in care homes to provide relief for the usual carer:

> *I found something different to that, because [respite care] isn't necessarily going into a home… [it] might just be another carer taking over…*
>
> *F3, Y1C3T1, U31.*

In fact, these were different examples of how the carer may be given respite, so this utterance was simultaneously coded as a positive manifestation of teaching presence, via the student **facilitating understanding**, but also as a negative manifestation of teaching presence, being a **missed opportunity** for the Facilitator to enable critical thinking: he could have asked students to derive a shared understanding of respite care. Further examples of **missed opportunities** to enable aspects of critical thinking were seen in steps 6 and 7 of the PBL process. Note that in step 7, the reflection step, only negative manifestations of soft scaffolding teaching presence were seen. For example, the following **missed opportunity** to encourage critique of resources:

> *… you couldn't really trust the information … whenever you use Google you have to be careful what you get.*
>
> *M3, Y1C3T1, U177.*

In PBL step 6, there were several examples of soft scaffolding teaching presence manifest as **facilitating process**, which is defined here as implying intention to change the direction of, or time-manage, the discourse. On one occasion the Facilitator was responsible, saying:

Can I ask a question?

Fac, Y1C3T1, U15.

He effectively stopped the group from moving on to the next topic prematurely and therefore facilitated a prolonged discussion of the issue at hand. However, most examples of **facilitating process** were on the part of students. Most often it was M1, the Chair, who was responsible. In utterances 53, 68, 79 and 167, he facilitated the process by reading out the next PBL objective. Since this also reflected the actual steps of the PBL process, these utterances were simultaneously coded to the **structure** category of teaching presence: this illustrates an interaction between different categories within a single element of the adapted CoI Framework (see 8.4.1). Further examples of students **facilitating process** include the utterance earlier offered as an example of the **open communication** category of social presence:

Anything else, any more questions?!

M1, Y1C3T1, U34.

In an attempt to manage time, the Chair was trying to draw to a close the lengthy exchange following the Facilitator's earlier question (U15). Here, social presence enabled the expression of teaching presence, since without the safe environment implied by *risk-free expression*, the Chair may not have been able to facilitate the process in this manner.

PBL Steps 6 & 7: Hard scaffolding – structure and resource.

Apart from the aforementioned **structure** afforded by the PBL process, there was little evidence for hard scaffolding in that part of the discourse representing PBL step 6. The students did not, and were not encouraged, to refer to the scenario; and the social medicine topics rendered the whiteboard unnecessary for drawing diagrams. However, the inquiry initiated (Simons & Ertmer, 2005) by the scenario stimulated productive

discussion and thus the scenario indirectly enabled critical thinking. As might be expected, even in the brief time allotted to step 7, there were several examples of the **resource** category of teaching presence, as students referred to a variety of textbooks used during their independent research.

6.3. Group Y1C3, Steps 1 to 5 of scenario about stroke.

Group Y1C3 moved on to explore a new scenario about stroke (Appendix H). Different students assumed the role of Chair and Scribe: respectively, M3 and M4. In this discourse, there were clearly different patterns of cognitive, social and teaching presence associated with different steps of the PBL process. Moreover, there were examples of categories and indicators not seen in the other half of this PBL tutorial.

6.3.1. Cognitive presence.

PBL Step 1: External exploration.

Step 1 of the PBL process, defining terminology, was associated with the *resource* indicator of the **external exploration** category of cognitive presence, when M4 (U10) asked whether he should look up a dictionary for a definition of stroke; and when F3 (U18) read out this definition.

PBL Step 2: Trigger, external exploration, internal exploration, integration & resolution.

As expected, PBL step 2, identifying issues, was associated with several instances of the **trigger** category of cognitive presence: seven separate utterances identified an *issue* to be explored; they were contributed by four students, two of whom each identified more than one issue. In step 2, there were also indicators for all other categories of cognitive presence. An example of **integration** came when F4 related back to a previous PBL scenario in the *course*:

Is Bruce's mother the demented one?

F4, Y1C3T2, U56.

This was simultaneously coded as **external exploration** via *seeking confirmation* of factual information. Following an affirmative response, F4 continued:

… okay, so it's not that she's had a stroke. Because I was thinking perhaps some sort of hereditary kind of thing, but never mind.

F4, Y1C3T2, U58.

Four indicators of cognitive presence were attributed to this single utterance, which therefore came close to representing critical thinking in its entirety. It was an example of **integration** via *connecting ideas*: the idea that the patients in two scenarios were related, with the idea that they may both have suffered the same clinical problem, with the idea that clinical problems that occur in families may be hereditary. By referring to a character in a previous scenario this was also an example of **integration** with a previous part of the *course*. In U58, by suggesting there could be an hereditary component to Bruce's stroke, F4 demonstrated *hypothesis formation* and hence **internal exploration**. She then rejected the hypothesis, probably because she was most familiar with Alzheimer's dementia; but as M3 and F3 later elaborated, strokes can predispose to vascular dementia. Finally, in U58, F4 explicitly referred to her thoughts, demonstrating meta-cognitive knowledge (see 3.3.1), hence the utterance was also coded to the *meta-cognition* indicator for **resolution**.

Still within Step 2, ordering issues by numbering gave rise to further examples of **external exploration**, **internal exploration** and **integration**, illustrated in Table 6.3. Utterances 79, 81 and 82 offer an excellent example of the way in which discourse aids critical thinking: F3 made a suggestion, but an alternative was offered by her peer, F1. F3 then integrated her peer's comment with her own knowledge on the pathophysiology

of stroke and realised it was more logical to discuss the normal blood supply first, then how its impairment may lead to stroke.

Table 6.3.: Cognitive presence during numbering of issues in Step 2 of the PBL process [group Y1C3, transcript 2].

Category	Indicator	Utterance	By	Text
External exploration	Seeking clarification	104	M2	And is the Acute Stroke Unit going to go in with that? [They were combining two issues].
Internal exploration	Offering suggestions	79	F3	I think we should go for stroke as number 1.
	Ditto	81	F1	[or] the blood supply to the brain.
Integration	Integrating with a peer's comment and existing knowledge	82	F3	Actually, that might be better to look at first, because stroke is the loss of it. So maybe we should look at the supply first.

PBL Step 3: External exploration, internal exploration, integration & resolution.

In the brainstorm, U109 to U625, most of the five hundred utterances were coded to one or other indicator of cognitive presence. Unsurprisingly, there were no examples of the **trigger** category, but there was evidence for all other categories of cognitive presence and hence substantial evidence for aspects of critical thinking by this CoI.

Two runs of utterances were extended examples of *information exchange*, and hence **external exploration**. These occured when the CoI was discussing the blood-brain-barrier and when they were stating risk factors for stroke. In each case, students reiterated snippets of information which may have been learned earlier in the course, but

these were not coded as integration, because the source of information was not made explicit. Other indicators of **external exploration** included *seeking information by asking a question*:

> *Is an aneurism a stroke or is it just an aneurism?*
>
> *M3, Y1C3T2, U187.*

Or *seeking clarification*:

> *What did you say, sorry? Tingling all the way to what?*
>
> *M4, Y1C3T2, U223.*

Or *seeking confirmation*:

> *Do you not have exercise programmes as well?*
>
> *M1, Y1C3T2, U384.*

There were subtle distinctions in the purpose of these questions and/or the apparent knowledge the questioner had on the topic. In U187, M3 asked a straightforward either/or *question* to which he clearly didn't know the answer. In U223, M4 sought to *clarify* what was said earlier. In U384, the wording indicates that M1 thought there were exercise programmes for rehabilitation of stroke patients, but he sought *confirmation*. For some utterances it was less easy to be certain whether the questioner was seeking an answer, clarification or confirmation, but it was nevertheless clear that their questions were examples of **external exploration**.

The brainstorm also contained plenty of examples of **internal exploration**, representing a creative thinking component (Garrison, 1992) of critical thinking (Table 6.4).

Table 6.4.: Indicators of the internal exploration category of cognitive presence during the brainstorm step [group Y1C3, transcript 2].			
Indicator	Utterance	By	Text
Hypothesis formation	472	F4	If it's an ischaemic … [stroke] …then would you use something like clot busting drugs …? [in relation to treating stroke].
Explanations (tentative)	596	M4	People … think, oh, I've got high blood pressure, what can the doctor do about that, nothing, so they won't bother going [regarding compliance].
Offering suggestions/ alternatives	521	F4	Or just people who haven't [yet] been diagnosed with high blood pressure … [a suggestion of who is 'below the surface', in relation to risk of stroke].
Exemplifying	587	F3	… if you've got something more visible you're more likely to go as well. If you've got a rash on your face you're [more] likely to go than if you've got a rash on your back [exemplifying the concept of triggers for consultation].

Many examples of **integration** were seen in the brainstorm, illustrated in Table 6.5. To be identified as an example of **integration**, rather than information exchange, the text had to explicitly identify the idea, knowledge, part of the course, question, peer comment, experience or evidence being integrated with the issue at hand. Some of the examples in Table 6.5 bear further explanation or discussion. In U522, M3 was linking the *idea* of a transient ischaemic attack, TIA, of which the patient himself may not have been aware, with an idea arising from the concept of the iceberg of illness: that things under water fail to come to the attention of health professionals. This was simultaneously coded as an example of **resolution**, since M3 was *applying ideas* about the iceberg of illness to his knowledge of TIAs; or one could say he was *reflecting on*

Table 6.5.: Indicators of the integration category of cognitive presence during the brainstorm step [group Y1C3, transcript 2].			
Indicator	Utterance	By	Text
Connecting ideas	522	M3	If you've had a transient ischaemic attack you may not have gone to the doctor's and that's under water isn't it [connecting the idea of a potentially symptomless condition with lack of visibility to the health services].
Relating to existing knowledge	531	F4	…there's the Keep Well health check so when you're over 55 … they'll ask you to come and get everything checked …
Relating to other parts of course	439	F2	We had a visit to the stroke unit in the Royal, ward 17 or 31, and they were … assessing them there and seeing how much damage had … been done … [Year 1 clinical visit].
Relating to question from peer	244	M3	That's if you've had … the haemorrhagic one. [in relation to student M1's question about pathophysiology associated with a stroke].
Relating to previous comment by peer	578	M4	Yeah, but they'd take that into consideration. They know that it's going to be high. [In relation to a comment about white coat hypertension in patients who are stressed by going to the GP].
Linking to experience outwith the course	220	M1	My dad had a stroke and he lost all control of the left side of his body and it was in the middle of the night and he says it gets really bad in the night. He's had a couple actually.

the consequences of silent TIAs in terms of what this meant for the iceberg of illness. Moreover, the inclusion of 'isn't it?' (M3, U522), denoted by dashed underlining, led to this utterance also being coded as **external exploration**, via *seeking confirmation*.

In U531, F4 demonstrated a new indicator for the **integration** category, *relating to existing knowledge* that was almost certainly derived from a previous part of the course, even though this was not made explicit. F4 was likely to have learned about Keep Well health checks in her reading for the Vocational Studies component of her course. U531 was not coded as *information exchange* because F4 was not simply relating information to answer a PBL objective; it was assumed she was linking something she already knew about to the discussion at hand.

There were several examples of *linking to a previous experience outwith the course*, but U220 was particularly striking, since M1 revealed that his father had had more than one stroke, and at least one of these sounded quite serious. This was clearly very personal and possibly had serious consequences for the father, so the topic was potentially a sensitive one. It was therefore disquieting to note the utterances (U221 to U224) immediately following this revelation:

M3: Really?

M1: Yeah. He's only 50 as well.

M4: What did you say, sorry? Tingling all the way to what?

F4: Paralysis and death.

On first reading of this transcript, it seemed that M4 and F4 were insensitive. However, from earlier in the transcript it was clear that M4, the Scribe, was poor at picking up everything that was being said and there had been several instances of group members reiterating information for his benefit; M4 and F4 were probably unaware of the conversation between M1 and M3. It was surprising there was no intervention from the

Facilitator at this point. He could have facilitated the group dynamic by pointing out that two conversations were happening simultaneously. He might have gently encouraged M1 to say more, giving him an opportunity to talk about his father's experience, whilst simultaneously facilitating the group's learning about stroke. Another possibility was that the Facilitator was displaying empathy by refusing to probe about a very personal issue. It was only on later viewing of the video that it became apparent the Facilitator was not in the room at this point in the discourse. He had exited temporarily during U215. Because he had not excused himself and the group had continued discussing the issue at hand, it was not apparent from the transcript or from the audio-recording, which illustrates the value of video-recording. It is unknown if it was significant or coincidental that M1 offered this information when the Facilitator was out of the room.

Finally, regarding **integration**, during the brainstorm there was no example of *relating back to evidence*. This is probably not surprising, because the students would not have known what topic was coming up in the PBL scenario and would not have researched it; as first years, they were unlikely to have existing knowledge of clinical or epidemiological evidence relating to stroke.

Examples of the **resolution** category of cognitive presence were evident during the brainstorming step (Table 6.6). Mostly, these were *application of ideas* or *reflection on the consequences* of new ideas. However, there were examples of *meta-cognition*, defined in this thesis as relating to meta-cognitive knowledge, meta-cognitive experience, and/or appraisal or judgment of one's thinking (see 3.3.1). There was explicit reflection on learning, related to self-regulated learning (see 2.3). Also, a new code was created to indicate *forming a judgment or conclusion*, which seemed consistent with resolution, since one application of new ideas could be to form a judgment. Regarding U346, this was seen as distinct from *hypothesis formation* or *explanation* because there was an element of prediction but also an element of certainty: if this, then that. U309 represented another **missed opportunity** for enabling critical thinking about multiple perspectives, such as why diabetic patients might continue to smoke and drink.

Table 6.6.: Indicators of the resolution category of cognitive presence during the brainstorm step [group Y1C3, transcript 2].			
Indicator	Utterance	By	Text
Application of new ideas	551	F2	… stopping smoking and alcohol intake, your diet. There's a lot of things that … may have to be changed at one time and people might find that really difficult to do [she applies the idea of the difficulty of changing a lifestyle behaviour to the number of risk factors that may need to be addressed, and concludes this may be difficult].
Reflection on consequences of new understanding	346	M2	Yeah. So they know how much of a burden they're being, so that can upset them as well [reflection on the consequences of awareness of one's situation, as a stroke patient].
Reflection on thinking (meta-cognitive knowledge)	58	F4	So it's not that she's had a stroke. Because I was thinking perhaps some sort of hereditary kind of thing, but never mind.
Reflection on learning	124	F3	We've had so many things on the brain and I've still never actually got … round to the …circle of Willis, and I think every time I go back to it that's one I've still not got to.
Forming a judgment or conclusion	309	F4	Well, if you're diabetic and you smoke and drink … it's not very sensible [forming a judgment based on her knowledge of the multiple risk factors for stroke].

PBL steps 4 & 5: External exploration.

In step 4, formulating questions, critical thinking could potentially manifest as meta-cognitive thinking about the intellectual tasks contained within a learning objective. However, in this discourse the evidence for cognitive presence in Step 4 was limited to a few examples of **external exploration**, as students *sought information by asking questions*, or *sought clarification*. In step 5 of the PBL process, identifying resources, critical thinking could potentially be demonstrated in judging the relative merits of different resources, but this was not seen.

6.3.2. Social Presence.

There was considerable evidence for social presence in this half of the PBL tutorial, and indicators were peppered throughout the five steps of the process. As with cognitive presence, specific categories and indicators of social presence were distributed differently throughout the steps of the PBL process.

PBL steps 1 & 2: Group cohesion & emotional expression.

In steps 1 and 2, defining terminology and identifying issues, there were many examples of **group cohesion**. These included the Chair, M3, seeking volunteers to read the scenario (U1), and using 'we' (M3, U24) in his directions to the group, thereby creating a sense of *collaboration*. There were examples of students being *co-operative*, by agreeing or offering to take on tasks:

> *Do you want me to look it up then if you're scribing?*
>
> *F3, Y1C1T2, U15.*

Note, collaboration implies students working together on an equal basis to achieve a particular task; whereas co-operation implies a slight difference in balance between group members - those leading the task, and those giving support. There were several

examples of students giving *support for ideas*. For example, in response to the hypothesis that scenario character Bruce's mother's dementia may have had something to do with 'silent strokes' (M3, U59 & U60), F3 commented:

> *There was vascular dementia which was either caused by a single major stroke or the TIAs, the little ones.*
>
> *F3, Y1C1T2, U61.*

There were also examples of *agreement or concurrence in relation to the PBL process* (U75). The final example of **group cohesion** that featured particularly in step 2 was *reiteration*. The Scribe did not pick up on everything that was being said and there were several examples of him seeking clarification and a peer, usually F3, reiterating what had just been said. There was no indication that she or any other student became impatient. In fact, there was a good atmosphere, with examples of **emotional expression** in the form of *jokes* and *laughter*.

PBL step 3: Emotional expression, group cohesion, open communication & negative manifestations.

In PBL step 3, brainstorming, there continued to be examples of **emotional expression** and **group cohesion**. Regarding the latter, in response to M1's revelation (U220) that his father had had strokes, the Chair said 'Really?' (M3, U221). Listening to this response on audio- or video-recording, the intonation suggests M3 was quite shocked; his comment was interpreted as an acknowledgement of M1's contribution, indicative of *interpersonal support*, a new indicator for **group cohesion**. In another example, F4 described how she kept telling her dad to stop smoking and that he eventually did; in a show of *interpersonal support*, F3 said: '[That was] Down to you' (U609).

In the brainstorm there were several examples of *risk-free expression*, indicative of **open communication**. When the Facilitator referred to revisiting of topics and said, '… there is a sort of plan in this, you know' (U127), one student replied with: 'That's very clever'

(F3, U128), which might be interpreted as a little cheeky. Similarly, when the Facilitator nodded in response to a question from M2, F4 said: 'That's a yes apparently.' (U382). Clearly, these students were not inhibited by the Facilitator, despite his prominence in the Medical School, or his being a highly-experienced member of the profession they aspired to join.

On a few occasions during the brainstorm, there appeared to be **negative manifestations** of social presence**.** The group as a whole seemed *unduly judgmental* when laughing at a question from M1, about whether patients are given morphine when they come out of hospital. In U625, F3 did not seem to pick up on the Chair's hint that they should move on to setting questions, and told an anecdote, thereby showing a *lack of cohesion*. In U424, M3 was supporting the suggestion by F3 that the Acute Stroke Unit, ASU, was where stroke patients were rehabilitated and he went on to say there was no need to brainstorm ASU, since they had already brainstormed rehabilitation. However, rehabilitation occurs in other contexts, so it is not synonymous with the ASU; U424 was therefore interpreted as a negative manifestation of social presence in terms of its impact on PBL, because whilst these two students were supportive of one another, the *dynamic* between them threatened to short-circuit the brainstorm in this instance. Thus, a negative manifestation of social presence potentially impeded aspects of critical thinking.

PBL Step 4: Group cohesion, emotional expression, open communication and negative manifestations.

Group Y1C3 spent considerable time setting and ordering the objectives to guide them in their research. However, their joint ownership of questions, and utterances indicating a *collaborative* approach, provided evidence for **group cohesion**. This category also manifest as *support for an idea*, *interpersonal support* and *reiteration*. At one point, M3 contradicted F4, who had said they hadn't previously learned the blood supply to the brain:

I did the circle of Willis …

M3, Y1C3T2, U638.

F3 quickly jumped in with:

Only because you were taught [laughs].

F3, Y1C3T2, U639.

Initially, U639 was coded as a **negative manifestation** of social presence on the basis that F3 was *teasing* M3 and potentially undermining his contribution to the discourse. On reflection, the generally good dynamic between M3 and F3 suggested this mild teasing was an acceptable way for F3 to question M3's thinking. Moreover, the implication was that F3 distinguished between knowledge acquired through having been taught something, and knowledge acquired through having learned it. This implies she distinguished between passive acceptance of information, and active inquiry and processing of information to facilitate understanding. So U639 was re-coded to the **resolution** category of cognitive presence, in that it evidenced *reflection on learning*. Moreover, by drawing attention to the distinction between being taught and learning, F3 potentially **facilitated development** of her peers, by *facilitating reflection/meta-cognition*, though it is unclear if this was intentional, or successful. Thus, a potentially negative manifestation of social presence was re-interpreted as an interaction between cognitive presence and teaching presence.

During step 4 there were many examples of **emotional expression**; and some evidence for **open communication**. Regarding the latter, M1 referred to the iceberg of illness, mortality and other concepts related to epidemiology and preventative medicine, saying:

…all that rubbish.

M1, Y1C3T2, U716.

U716 was coded as *risk-free expression*. It showed M1 was unconcerned about being frank in front of the Facilitator. The remark may have been intended as a joke, but could also be interpreted as a **negative manifestation** of teaching presence in that M1 was *undermining specific specialties*. This utterance also represented a **missed opportunity** to enable critical thinking, by pressing M1 for justification of his statement. Further, U716 showed that M1 was comfortable with having this view recorded. Either he had forgotten he was being recorded, or he trusted that his participation would not have negative repercussions. A new code was generated, **research**, for utterances related to participation in the study or to perceptions of this research. This code was not part of the CoI Framework, but was deemed important for future work in this area, since it provided information about participants' engagement with the research process. Further examples of the **research** category were:

> *Recorded for posterity [laughter].*
>
> *Fac [all], Y1C3T2, U717.*

> *It's okay. We're meant to be confidential on this except on the videos.*
>
> *F3, Y1C3T2, U718.*

The Facilitator's joke (U717) was possibly a subtle reminder to M1 that the proceedings were being recorded; but F3 reassured M1 about confidentiality: this confirmed prior engagement with the consent process. There was clearly a degree of trust on the part of the students, exemplified by a further risky comment on a question about patient compliance related to the iceberg of illness:

> *That's one of those airy, fairy questions [laughter].*
>
> *M3, Y1C3T2, U726.*

6.3.3. Teaching presence.

In analysing the data, for ease of identifying interactions between the three elements of the CoI framework, different-coloured highlighter pens were used to mark up indicators of cognitive presence, social presence and teaching presence. The colour distribution made it instantly clear that in steps 1, 2 and 4 of the PBL process, indicators of teaching presence were more likely to be interspersed with indicators of social presence, whereas in step 3, they were generally interspersed with indicators of cognitive presence.

PBL Step 1: Facilitating process; structure and resource.

In step 1, defining terminology, there were instances of soft scaffolding teaching presence, when the Chair or other students **facilitated process**, with prompts to follow the *process* and a *prompt to the Scribe*. Hard scaffolding teaching presence manifest in the **structure** of the PBL process, via references to the *steps*; and, unsurprisingly, in the **resource** provided by Faculty, with direct reading from - or reference to - the PBL *scenario* and specific reference to a *dictionary*.

PBL Step 2: Facilitating process, development and understanding.

In step 2, identifying issues, there were examples of the Scribe, M4, giving *prompts to the Group*, asking them to slow down. As aforesaid, he had trouble keeping up with the discussion, but this provided several examples of interaction between teaching presence and social presence. Thus in U41, U43 and U46, students F3, F1 and M3 respectively reiterated information for the Scribe's benefit; in so doing, they were **facilitating process** through a *prompt to Scribe*, but they were also enhancing **group cohesion** by *reiteration*.

In the Facilitator's first intervention in this half of the tutorial, he simply nodded, an example of silent scaffolding (Carter *et al*, 2006). In so doing he **facilitated development** by *providing support* for the Chair's suggestion (U52) that the group should consider patient compliance with health checks. There were two examples of

students **facilitating understanding**, whereby they *sought support* for their ideas. The first was in the context of the Acute Stroke Unit, ASU:

That's where they do their rehabilitation isn't it, normally?

F3, Y1C3T2, U49.

This is not wholly accurate: the ASU is where stroke patients receive immediate treatment; rehabilitation may commence in the ASU, but is mainly provided in a separate Stroke Rehabilitation Unit, or via other options such as supported home care. Note that the Facilitator did not step in to correct F3, although he picked up on this misunderstanding some way through the brainstorm (U426). U49 was seen as distinct from seeking confirmation of something effectively known. This makes an assumption about F3's degree of certainty and my interpretation may have been influenced by my appreciation that her understanding was not wholly accurate. The Scribe provided the second example of **facilitating understanding** by *seeking support* for ideas. Responding to the Chair's suggestion that they should 'look at the fact that … [the patient] … stopped going back for a check-up' (M3, U53), M4 related this to the concept of patient compliance, but sought support for his understanding:

What, should I put that down as patient compliance or something?

M4, Y1C3T2, U54.

PBL Step 3: Facilitating process, development and understanding; directive, missed opportunities, resource.

In step 3, brainstorming, there were proportionally fewer instances of teaching presence compared with other steps, with occasional runs of indicators of teaching presence. There were examples of **facilitating process**, with prompts about the *process*, or to the *Scribe*. The Chair also made direct reference to *time*, when he noted they were 'going pretty quick' (M3, U478). The Facilitator began to give verbal input, saying:

Don't you just love these ones which sort of revise the …

Fac, Y1C3T2, U121.

Here, he was **facilitating development** by effectively *giving feedback to the group,* that they had already encountered the blood supply to the brain. He also gave *individual feedback* to F4 when she made an inadvertent pun about having 'something in her head' (F4, U149) about the circulation of cerebrospinal fluid: he told her to 'rephrase that' (Fac, U152). Later in the brainstorm there were several examples of the Facilitator employing a further mode of **facilitating development**; namely, giving *support* to the group by providing information that responded to, confirmed and built on their contributions:

- U442 - confirming M2's suggestion that for haemorrhagic stroke the priority is to stop the bleeding, and building on this to tell the students that morphine or an anti-coagulant would be inappropriate in this context;
- U473 - confirming F4's hypothesis that ischaemic stroke patients would be treated with clot-busting (anti-thrombolytic) drugs;
- U495 & U497- building on F4's query about whether this scenario featured the wealthier family, asking if the featured patient was the 'managing director guy' (Fac, U495), claiming to be 'a bit confused about who was who[m]' (Fac, U497).

U495 was simultaneously coded to the **resource** category, since the Facilitator referred to the PBL *scenario*. This constituted interaction between different indicators within a single element of the CoI Framework: namely, the **resource** and **facilitating development** categories of teaching presence. Regarding U497, it was highly unlikely the Facilitator was confused about who was whom in the scenario, given that he helped write it and had been facilitating this material for many years. It is far more likely he was prompting the students to think about lifestyle issues for managing directors, and he was successful:

So he's probably all stressed out.

M2, Y1C3T2, U496.

He's probably quite stressed as well.

M3, Y1C3T2, U509.

These *hypotheses* were indicative of the **internal exploration** category of cognitive presence, so this line of discussion offered an example of an interaction between teaching presence and cognitive presence. A further example of interaction between these two elements of the CoI Framework related to discussion about the now-defunct Keep Well campaign. In explaining why stress and high blood pressure might be missed in relatively young people with managerial jobs, F4 said (U533) that for under-55s there was no similar system for calling people in for health checks. The Facilitator highlighted that the Keep Well campaign did not apply to more affluent communities:

But he lives in the posh part and the Keep Well thing was for the deprived areas wasn't it?

Fac, Y1C3T2, U534.

Plus it's had its funding stopped anyway so …

Fac, Y1C3T2, U536.

No funding at all, that's right.

Fac, Y1C3T2, U545.

U534 and U536 were coded as **facilitating development** through *support* for ideas, since, although corrective, they built on F4's comment; U534 was also coded as an example of **facilitating understanding** by identifying *conflicting information*. U536

seemed directive, initially, but the word 'so' allowed it also to be coded as **facilitating understanding**, manifest as *prompting further reflection.* This run of soft scaffolding interventions by the Facilitator led directly to **internal exploration** by F3, who *suggested alternatives*:

> *So maybe they should have funded the rich bits.*
>
> *F3, Y1C3T2, U538.*

Internal exploration was also exemplified by her *alternative perspective* on the view that more affluent areas did not need certain health services:

> *… things are going downhill for them because oh, well, we've got some funding there, shall we give it to X [less affluent] or Y [more affluent]? It always goes to the poorer areas. So they've not got any funding [in Y] because it's a rich area and they presume that they can afford to pay for it themselves.*
>
> *F3, Y1C3T2, U546.*

The Facilitator's interventions also led to **integration** with other parts of the *course*:

> *Like you say with the lack of funding, we found that in the Community Diagnosis [project] in Y [affluent area] … they're getting no funding for anything.*
>
> *F3, Y1C3T2, U542 & U544.*

Students occasionally demonstrated teaching presence by **facilitating development** or **facilitating understanding**. They appeared to promote the **internal exploration** category of cognitive presence by their peers. In relation to the point that having one stroke makes you more susceptible to having a second, M3 **facilitated understanding** by identifying *conflicting information*:

> *I can't understand this. Once you've had one surely you're … monitored more …*
>
> *M3, Y1C3T2, U353.*

This was followed by examples of **internal exploration** by his peers: a series of *hypotheses*, then M2 *explained* (U361) that a patient would still have many of the risk factors that led to the first stroke. M3 then **facilitated development** by providing *support* for this idea:

> *I suppose you would still have the [atherosclerotic] plaques as well, you can't get rid of any previous [ones].*
>
> *M3, Y1C3T2, U365.*

In addition to facilitative interventions, the Facilitator made several **directive** interventions during the brainstorm, providing *didactic information*, *advice* and *direct answers* to students' questions, this last necessitating a new code. In the featured curriculum facilitators are explicitly asked not to act as a direct resource of information, but as the brainstorm turned to more clinical aspects, it appeared this Facilitator found it hard to resist displaying his knowledge. Unwarranted provision of didactic information about implanting stents (U454) was simultaneously coded as **directive** and a **missed opportunity** to turn the question back on the group and ask them to think about the procedures that might be necessary before such an operation. There were further missed opportunities to probe students' understanding or encourage them to form hypotheses. In the single instance where the Facilitator tried to **facilitate understanding** by asking a *probing question* about the effect of high salt intake (U282), M1 answered, 'Increases your blood pressure' (U283). Whilst correct, this was superficial. Thanks to the popular press it is arguably common knowledge that high salt intake leads to high blood pressure. So this represented another **missed opportunity** to press for an hypothesis about the mechanism by which high salt intake might lead to high blood pressure.

Finally, in terms of the impact of hard scaffolding on critical thinking, one example was the interaction between the **resource** category of teaching presence and the **integration** category of cognitive presence. F2 referred to the earlier reading of the *dictionary* and integrated this with the *idea* that the consequences of a stroke can be varied:

> *And you had read out from the dictionary that it ranges from slight tingling to actual paralysis or death.*
>
> *F2, Y1C3T2, U281.*

By *applying* the concept of the iceberg of illness to the specific individual in the PBL *scenario*, an indicator for the **resource** category of teaching presence, F1 demonstrated the **resolution** aspect of cognitive presence:

> *This guy was on the tip of the iceberg because he got his blood pressure diagnosed but then he … went back below the surface because his blood pressure's probably rising again but he felt fine so he didn't [get it checked]…*
>
> *F1, Y1C3T2, U526.*

PBL Step 4: Directive; facilitating understanding, development and process; negative manifestations; structure and resource.

Soft scaffolding teaching presence manifest in various ways during step 4, formulating questions. The Facilitator was **directive** and offered *advice* on the wording of questions. He suggested relating the blood supply to the brain 'to the clinical features of stroke' (U644). This was a good suggestion because it should have encouraged students to understand the significance of inadequate blood supply to specific parts of the brain. F4 picked up on this and tried to **facilitate understanding** by *seeking support* that she had understood correctly:

Oh, so perhaps … what happens [when] certain areas are blocked or something …so this area's close to this one or something …

F4, Y1C3T2, U645, 647, 649.

The Facilitator **facilitated development** by *providing support* for her ideas:

Yeah. So if you had a stroke on your occipital pole you might be blind on one side of your eye …

Fac, Y1C3T2, U650.

This exchange was a good example of interaction between different categories of teaching presence. There were a few examples of participants **facilitating development** by *facilitating meta-cognition*:

So is that a revision question or are we going to talk about it?

F4, Y1C3T2, U633.

I think we should probably talk about it because no-one really seems to know do they?

F3, Y1C3T2, U634.

Is [pathogenesis] the right word? I get confused. That's the mechanisms of it isn't it.

F4, Y1C3T2, U660.

This group seemed to have an established practice whereby some of their questions were solely for personal revision, whilst others were to be discussed, and what distinguished the two was whether the students already knew, or should have known, the material. It was not clear whether they truly understood the purpose or benefit of verifying their

personal constructions of knowledge, or whether they did this solely because they knew it was expected of them. Note that in U633, the **facilitating development** category of teaching presence interacted with the **group cohesion** category of social presence, since F4 used the word 'we' and presumably sought consensus. In U634 the interaction was between teaching presence and the **trigger** category of cognitive presence, since F3 referred to a *gap* in the group's knowledge. Finally, in U660, the interaction was between teaching presence and the **external exploration** category of cognitive presence, since F4 *sought confirmation* of the meaning of pathogenesis. She also alluded to a meta-cognitive experience, feeling confused, so this utterance was simultaneously coded to the **resolution** aspect of cognitive presence, since it was an example of *reflection on [an aspect of] meta-cognition*.

Close to the end of this half of the tutorial, the Facilitator made an utterance that was a **negative manifestation** of teaching presence:

> *I can't be bothered writing iceberg so I've drawn an iceberg [laughter].*
>
> *Fac, Y1C3T2, U730.*

The students had been trying to formulate a question about patient compliance with health checks, in relation to the iceberg of illness. By joking about this, the Facilitator potentially signalled that it is not critical to word questions carefully, which is unfortunate, since the questions define the focus or depth of learning. U730 impacted negatively on students' engagement with the question-setting step of the PBL process, and potentially on the students' subsequent learning. Because this intervention was made in relation to a social science concept in Public Health, the Facilitator's comment may have *undermined this specialty*. One final consequence was that the discussion deteriorated into a series of *jokes* about students' illustrations of icebergs and seals. In fact, the Facilitator had to intervene to bring the group back on track.

In terms of hard scaffolding in step 4, there were many utterances relating to **structure**: either to the *steps* as a whole, or a specific reference to *setting questions*. There were utterances related to **resource** (Table 6.7), whether the *scenario*, future *learning opportunities*, or some other specific *resource* for addressing the learning objectives. In all cases, the **resource** category of teaching presence interacted with social presence, manifest as **group cohesion** (U629) or **emotional expression** (U655 and U672).

PBL Step 5: Structure and Resource.

In the brief final step, identifying resources, there were a few utterances related to **structure** or to **resource.**

Table 6.7.: Examples of the resource category of teaching presence during the question-setting step of the PBL process [group Y1C3, transcript 2].

Utterance	By	Text
629	F4	[To scribe] I'll do your questions [referring to the fact that the hard copy scenarios have boxes for writing down the agreed questions].
655	Fac	Okay, so that's the first quarter of an hour lecture [laughs]. Which I haven't written yet so I'm looking for guidance as to what you want me to tell you [laughter].
672	F3	I like it when we have words like pathology in it because I need to go to Pathology [texts] to get the answer [laughs].

Analysing the discourses featuring this single PBL group, Y1C3, has given preliminary answers to the research questions. Already, there is evidence for aspects of critical thinking in each step of the PBL process; evidence for social and teaching presence throughout the discourses; and interactions between different elements of the adapted CoI Framework, with instances of teaching presence enabling cognitive presence. The next Chapter will analyse discourses featuring other PBL groups and will compare the findings with those from Y1C3.

Chapter 7. Analysis and interpretation of discourses by other PBL Groups, in comparison to Y1C3.

This Chapter analyses and interprets the discourses by five other PBL groups in this study: Y1B2, Y1B3, Y1A3, Y2B3 and Y2C3 (Appendix H). It highlights similarities and differences between these and the discourses featuring Y1C3.

7.1. Group Y1B2, Steps 6 &7 of scenario about care of the elderly.

This second group of first year students debriefed on their independent research for the scenario about care of the elderly. Categories and indicators of cognitive, social and teaching presence were identified and displayed on an Excel spreadsheet (Appendix J), alongside those from the corresponding discourse by Group Y1C3, giving a visual representation of similarities and differences, which aided analysis.

7.1.1. Cognitive presence.

PBL Step 6: External exploration, internal exploration, integration and resolution.

As with Y1C3 (see 6.2.1), in the information-sharing step 6, there was evidence of students engaging in the **external exploration**, **internal exploration**, **integration** and **resolution** categories of cognitive presence. For example, **integration** via *relating to experience outwith the course* was illustrated in utterances about financing care of the elderly:

> *We have … a similar thing in Hong Kong, … you pay tax to the government and when the elderly need help they … just use the amount of that money you paid before to provide [a] health service …[and]… when the patient dies [his estate] can actually get back [the rest of] the money.*
>
> *M1, Y1B2T1, U153 & U155.*

In the following example of **resolution**, the student *formed a judgement* about the care of patients at different stages of dementia; the utterance was simultaneously coded to **internal exploration** because F2 provided an *explanation* for her judgment.

> *I don't think it is appropriate to have people who are [in the] early stages of dementia beside those whose disease has progressed, it must be terrifying.*
>
> *F2, Y1B2T1, U135.*

Indicators of cognitive presence were seen that were not found in step 6 of the discourse with Y1C3; for example, **external exploration** by *seeking confirmation* (U154) or *seeking clarification* (U57) and occasional instances of the **trigger** category, such as when a student expressed *puzzlement* (U200). There were also **negative manifestations** of cognitive presence, when participants placed a *limit on learning*. Thus, when the Chair asked the group to address their objective about treatments for dementia:

> *I didn't go into this too much because I think we covered it last time.*
>
> *M4, Y1B2T1, U167.*

The notion that a topic has been covered and that one's knowledge is complete seems at odds with the notion that medical students will be lifelong learners.

PBL Step 7: External exploration, internal exploration, integration and resolution.

Group Y1B2 demonstrated several aspects of critical thinking during the reflective step 7. For example, in discussing the difficulty finding suitable Scotland-centric resources about care in the community:

> *If you were the person in a position looking for [this information], it would be quite difficult, … we were just looking for PBL but… if you were actually … trying to find any information, it's not that easy. I*

thought that was the point of the carers' websites.

F1, Y1B2T1, U285.

This demonstrated **resolution**, since F1 *applied ideas* about the difficulty finding relevant information and *reflected on the consequences* for carers. Her peer provided an example of **internal exploration**, when he gave this *explanation* for the limited usefulness of some information sources:

A lot of these helplines … are based down in … England and … only [give] you …their …statistics, … their facts and figures …

M3, Y1B2T1, U287.

7.1.2. Social presence.

This discourse contained evidence for all three categories of social presence as defined by Garrison *et al* (2000): **emotional expression**, **open communication** and **group cohesion**. Some utterances were coded as **negative manifestations** of social presence: when F1 talked (U249) about the possibility that vitamin E could be a preventative measure against dementia, F3 was *unduly judgmental* in her response (U250); there was also occasional *lack of cohesion*, such as when M2 (U117) ignored the Chair's suggestion that they move to the next objective. However, the learning environment was positive, overall. Although there was no direct evidence that this enabled aspects of critical thinking, a positive social environment should provide the safety for students to practise cognitive skills such as *hypothesis formation*.

7.1.3. Teaching presence.

PBL Step 6: Facilitating development, process and understanding; negative manifestations; resource.

Soft scaffolding teaching presence was contributed by the Facilitator and by students. This Facilitator intervened considerably more, and in more varied ways, than the Facilitator of Group Y1C3. They each **facilitated development** and **facilitated process**. By saying 'there's a purpose then' (Fac, U80), this Facilitator combined the two categories: she provided *developmental support* by indicating she accepted the point being made, but she also closed that line of discussion. Elsewhere, she made *questioning* interventions that **facilitated understanding**. She tended to ask closed questions leading to brief responses, but the following was a more productive exchange:

> *Do you think it is a cost issue then, is it cheaper to keep someone at home?*
>
> *Fac, Y1B2T1, U94.*

> *… by the time they're really severe it's slightly more expensive to give them really, really intensive care in their house rather than just put them in a nursing home. There are things about nursing homes that - I don't understand how this can be true - but, some NHS nursing homes cost the council more money per week than a private one, I don't know whether that's because they have more … actual qualified nurses and less auxiliaries, and that's why … depending on where you live… you'll get funded and put into a private one, because a lot of them are actually cheaper to run than an NHS one, which I thought was strange.*
>
> *F3, Y1B2T1, U96.*

Here, F3 demonstrated **internal exploration** by *explaining* that it may be cheaper to care for a patient with severe dementia in a nursing home, as opposed to their own home. She demonstrated **external exploration** via *information exchange* by stating that some NHS nursing homes cost local authorities more per week than private ones. In acknowledging that she didn't understand this, she demonstrated meta-cognitive experience, coded to the *meta-cognition* indicator for **resolution**. She then showed further evidence of **internal exploration**, *hypothesising* that NHS homes may have more qualified nurses and fewer auxiliaries, accounting for their higher costs. Thus teaching presence (U94) directly enabled a rich example of cognitive presence (U96).

A new indicator for **facilitating understanding** was *providing clarification*. Utterances coded in this way had to build on previous student contributions; this is similar to the *developmental support* indicator for **facilitating development**, but the purpose is providing clarification, rather than support. For example, when M3 demonstrated **internal exploration** by *explaining* the differences between care options for patients with dementia (U74), he indirectly **facilitated understanding** by clarifying the distinction between care options. So cognitive presence directly enabled soft scaffolding teaching presence.

In the following example, cognitive presence manifest as **external exploration** via *information exchange* and **integration** via *empirical evidence*, but also represented a negative example of teaching presence, being a **missed opportunity** for the Facilitator to get the students to consider the source, quality and level of evidence:

> *I just got the number of carers is increasing and that caring is actually detrimental to your health[,] fifty two percent of carers are treated for stress related illnesses, fifty one for physical injury, forty for poor psychological health[,] and that just general being a carer increases your mortality risk by up to sixty percent …*
>
> *F4, Y1B2T1, U7.*

In one instance, the Facilitator asked a *question* (U40) to **facilitate understanding** of what constituted free personal care. The group provided *examples*, thereby demonstrating **internal exploration**. Thus teaching presence enabled cognitive presence. This was interrupted by M4 (U47), who started to talk about services provided for the carer. Perhaps he was aiming to facilitate the process, but there was still mileage in distinguishing what is and is not free personal care. So M4's intervention was coded as a **negative manifestation of social presence**, since he showed a *lack of cohesion*; and a **negative manifestation of teaching process**, in that he facilitated the process in such as a way as to *inhibit* (further) critical thinking about free personal care.

Hard scaffolding teaching presence clearly enabled cognitive presence. One lengthy utterance (M2, U203) about the mechanism of action of the anti-dementia drug Memantine contained several indicators for the **external exploration**, **internal exploration**, **integration** and **resolution** categories of cognitive presence. M2 drew a *diagram* on the whiteboard, and directly referred to this **resource** to facilitate his *explanations*; hence hard scaffolding teaching presence enabled multiple aspects of cognitive presence.

PBL Step 7: Facilitating process and development; structure & resources; negative manifestations.

Soft scaffolding teaching presence was identified in step 7, the group reflection. As well as **facilitating process** and **facilitating development** via *providing support*, a new indicator was **facilitating development** by *facilitating reflection*, when the Facilitator asked if web resources were the most useful for this scenario (U290). There was evidence for **structure**, via reference to the *steps*, and **resource**, via reference to *textbooks*. **Negative manifestations** of teaching presence included *difficulty in locating or using a resource*, as when F2 said it was difficult to find information specific to the Scottish context (U281). However, this was followed by positive interaction of teaching presence and cognitive presence:

The Scottish Executive website had quite a lot of good things but they were quite difficult to find … it was … useful but trying to find it … took hours. … one of the girls at work … studies social work and I got a lot of what to look up from her … she told me [that] putting handrails in is free but other things aren't. So I think it would have been better and easier and quicker if we just walked down to the social work department and asked them for leaflets.

F3, Y1B2T1, U292.

Teaching presence was evident as F3 described **resources** she had used, or could have used, and talking about these enabled the **resolution** aspect of critical thinking, since she *reflected on self-regulatory aspects of learning*.

7.2. Group Y1B2, Steps 1 to 5 of scenario about stroke.

7.2.1. Cognitive presence.

There was considerable similarity in the indicators identified in this discourse about stroke, and the corresponding one by group Y1C3. Thus all indicators of cognitive presence in step 1 of the PBL process, defining terminology, could be coded to the **external exploration** category; whilst in step 2, identifying issues, there were instances of the **trigger**, **external exploration**, **internal exploration** and **integration** categories of cognitive presence, although for Group Y1B2, there was no example of resolution.

In step 3 there were examples of most indicators for the **external exploration**, **internal exploration**, **integration** and **resolution** categories of cognitive presence. Unlike for Y1C3, there was some evidence for the **trigger** category, when students identified *gaps* in their knowledge. There was interaction between various categories of cognitive presence. For example, the following utterance was simultaneously coded to **external exploration** via *information exchange* and to **integration** by linking to *experience outwith the course*:

> *… my Dad had a stroke when he was thirty-eight, and he doesn't get anything for it now, he just gets put on aspirin … but they say … if you have it younger … it's more of a warning …*
>
> *F4, Y1B2T2, U480.*

U480 also illustrated interaction between cognitive presence and social presence. On the video-recording of this discourse, it was noticeable that other students were silent at this point, whereas they usually talked over one another (see 7.2.2). This was interpreted as a show of *interpersonal support*, an indicator of **cohesion**.

In step 4, formulating objectives, whereas group Y1C3 demonstrated **external exploration**, Y1B2 demonstrated **internal exploration** when group members offered competing *suggestions* about the focus of their questions; and also one example of **resolution**, when the Chair said:

> *Okay what do we want to split it up in to? The definition is probably the first thing you want to do ...*
>
> *F2, Y1B2T2, U738.*

This was coded to *reflection on learning*, since the Chair was trying to decide a logical order in which to ask questions, which would potentially facilitate learning. As with Group Y1C3, Group Y1B2 did not demonstrate cognitive presence in step 5, but in this case it was not due to negative aspects of teaching or social presence, but because the step comprised just two utterances.

7.2.2. Social presence.

PBL steps 1 to 5: Emotional expression, cohesion, negative manifestations.

As with group Y1C3, there were abundant positive indicators of social presence. **Emotional expression** and **cohesion** featured throughout steps 1 to 4. One difference

with Y1B2 was an absence of specific indicators for **open communication**, but there was nothing in the transcript or video-recording to suggest the group members were in any way inhibited.

However, there were several **negative manifestations** of social presence in this discourse and F3 seemed to be a major contributor in this regard. A lot of the *teasing* came from her, although people seemed to take it in good part. She also contributed to a *lack of cohesion* right from step 1. She asked if they should look up the definition of stroke and acknowledged that she was 'obsessed with looking up the dictionary' (U15). M3 retorted 'we did notice' (U16) and eventually the Facilitator said 'perhaps just a brief definition of it, because we don't want to… [wreck the brainstorm]'(U24). This suggests that inappropriate use of the dictionary was a recurrent issue with this student. Indeed, she read a substantial chunk of information from the *dictionary* (U46) and effectively summarised some of what students were expected to deduce during the brainstorm. In this case, the **resource** category of teaching presence impacted negatively on the **cohesion** category of social presence.

There were clearly problems with the *group dynamic*. The students were difficult to control, though not for the want of trying on the part of the Chair, F2. She made some good interventions, summarising and directing the discussion (U394, U657); and she continually tried to stop her peers talking over one another:

> *No talking! (F2, U160).*
>
> *One at a time, one at a time! What were you saying? (F2, U307).*
>
> *Guys, guys, we're all speaking over … (F2, U555).*

She tried to use the **structure** of the PBL process (U61) and her skills in **facilitating the process** to tackle **negative manifestations** of social presence, with limited success. The Facilitator did not particularly help to address the *group dynamic*. It may be that the disruptive behaviour of F3, and to a lesser extent M3 and M4, was tolerated by the CoI

because they also contributed to the positive aspects of social presence and made good intellectual contributions to the discourse. All aspects of cognitive presence were in evidence in this discourse (7.2.1), so negative aspects of social presence did not necessarily impede critical thinking. It may be that as long as the balance is towards a positive social environment, and positive social interactions, then critical thinking is not impaired.

7.2.3. Teaching presence.

PBL Steps 1 to 5: Facilitating process, understanding and development; directive; structure and resource.

Soft scaffolding teaching presence was contributed by the Facilitator and students. Reference has been made to the Chair's efforts to **facilitate the process** and attempt to address the *group dynamic*. The Facilitator and/or students **facilitated understanding** by *asking questions*, by identifying *conflicting information*, or by *providing clarification*. The Facilitator contributed soft scaffolding by **facilitating development** through providing *support* for ideas; and also by **didactic** interventions, albeit limited to giving *advice*. Hard scaffolding was evident in references to the **structure** of the PBL process and to **resources**.

A protracted discussion about the pathophysiology of stroke (Appendix K) provided multiple instances of teaching presence enabling aspects of critical thinking, and *vice versa*. The discussion began with M1 drawing a diagram of the blood supply to the brain and thereby using a hard scaffolding **resource**, the *whiteboard*, to enable the **external exploration** category of cognitive presence, via *information exchange*. This in turn led to soft scaffolding teaching presence through **facilitating understanding**, as F4 *sought support* for her understanding and one of her peers *provided clarification.* The Facilitator asked a *question*, which **facilitated understanding**; by addressing this to the whole CoI, she simultaneously enhanced the *dynamic* and thereby **facilitated process**. This enabled the **external exploration**, **integration** and **internal exploration**

categories of cognitive presence, as M3 *linked to experience* from a hospital placement and a dissection class within the *course*, to *hypothesise* that blood vessels must cross from one side of the brain to the other. He was attempting *explain* why damage to one side of the brain leads to symptoms on the contra-lateral, or opposite, side of the body. Demonstrating the **cohesion** category of social presence, F2 offered *support for his idea*, but F3 said it is the nerves that cross over, although she *hypothesised* that blood vessels may run alongside. M4 demonstrated **internal exploration,** as well as **cohesion**, by offering the unifying *explanation* that a lack of blood on one side of the brain damages the nerves; since these nerves cross the midline, the consequence is signs and symptoms on the contra-lateral side. F1 further *explained* that the presence of a blood clot causes the damage.

7.3. Group Y1B3, Steps 6 &7 of scenario about thermoregulation and malaria.

7.3.1. Cognitive presence.

A third PBL group, Y1B3, completed a scenario on thermoregulation and malaria. The discourse was characterised by relatively lengthy contributions from individual students. In step 6, sharing answers, cognitive presence was evidenced by multiple indicators of **external exploration**, **internal exploration**, **integration** and **resolution**, plus instances of the **trigger** category, arising from *gaps in knowledge*. For example, in trying to explain why some regions of the world are endemic for malaria, M1 (U99) demonstrated **internal exploration**, via *exemplification* of factors that affect malarial transmission, such as use of insecticides in agriculture; also, he demonstrated **resolution**, by *applying his knowledge* about failed eradication projects to address why some areas are endemic for malaria. This contribution followed the Facilitator's attempt to **facilitate understanding** by asking a *question*; hence providing an example of soft scaffolding teaching presence enabling aspects of critical thinking.

7.3.2. Social presence.

Apart from some fairly good-natured *teasing*, there were mostly positive examples of social presence in step 6: **emotional expression** in the forms of *jokes* and *laughter*; and examples of **cohesion**. An example of **open communication** was this *risk-free expression* about the relevance of learning the lifecycle of the *Plasmodium* parasite:

> *So the life cycle within the mosquito, which quite frankly I'm not a zoologist so I didn't bother learning, but [the parasites] end up getting into the salivary glands…*
>
> *M4, Y1B3T1, U31.*

This was also coded as a **negative manifestation** of teaching presence, since it was arguably *undermining a specific discipline.* Moreover, it was coded both as a positive indicator of the **external exploration** aspect of cognitive presence, and a **negative manifestation** of cognitive presence, in that there was an attempt to *limit learning*.

7.3.3. Teaching presence.

The Facilitator of Group Y1B3 **facilitated process** by suggesting the students draw a *diagram* (U9), or look at a *photo* of a blood film (U40), both types of **resource**. This represented interaction between soft and hard scaffolding teaching presence. She used *probing* to **facilitate understanding** about drugs used for treatment for malaria:

> *You touched … on the treatments for malaria, the ones you have mentioned are quinines and things like that; are there any other drugs that are used or any other groups of drugs that are used, once somebody presents? We've talked about prophylaxis, what about if somebody actually presents with malaria … ?*
>
> *Fac, Y1B3T1, U298.*

Moreover, by indirectly confirming that quinines are a management option for malaria, but not the whole story, the Facilitator **facilitated development** by providing *support*.

Group Y1B3 spent very little time addressing step 7, reflection. The Facilitator did encourage the students to reflect on their performance, but they failed to engage. In an utterance that was coded both as a positive and **negative manifestation** of teaching presence, M4 identified **resources** he had used, but indicated they were inadequate to address all the Group's objectives:

> *I didn't really find that much … the [information] in Vander [a physiology text] was quite good and .. [Tortora - an anatomy and physiology text] was quite good, but they both basically said the same thing, and it still … left questions unanswered.*
>
> *M4, Y1B3T1, U320.*

This represented a **missed opportunity** for the Facilitator to ask whether it was appropriate to expect physiology texts to have provided answers about signs and symptoms of infectious disease, travel medicine, pharmacology, and so on; or to ask what he intended to do about questions that remained unanswered. Unfortunately, the session ended on the following negative note:

> *But Vander's the one they recommend … isn't it, so that's fine, if you know Vander you're fine and sorted.*
>
> *F4, Y1B3T1, U321.*

This was a **negative manifestation** of cognitive presence in that it reflected a *limit on learning*. One wonders if this CoI was not in the habit of reflecting on its learning and dynamic.

7.4. Group Y1B3, Steps 1 to 5 of scenario about pneumonia.

7.4.1. Cognitive presence.

The second discourse by Group Y1B3 was about pneumonia. In step 1 of the PBL process, defining terminology, cognitive presence was limited mainly to **external exploration**, with some instances of the **trigger** category, due to *gaps in knowledge*. The group was going to look up the word cyanosed, but M4 said, 'I'm pretty sure I know what it is.' (U13). This was interpreted as meta-cognitive knowledge and coded to the *meta-cognition* indicator for **resolution**.

In step 2, there were examples of the *issues* indicator for the **trigger** aspect of critical thinking, plus indicators of **external exploration**, **internal exploration** and **integration**. In step 3, brainstorming, there was ample evidence for all five categories of cognitive presence (see 7.4.3).

In step 4, formulating questions, instances of cognitive presence included **external exploration**, as students *sought clarification*; **internal exploration**, as they *suggested alternative* questions; and **integration** by reference to a science lab in the *course*. M4 asked if they had to 'cover' (U586) bacteria in general; initially, this was interpreted as a **negative manifestation** of cognitive presence, via *limiting learning*. However, based on his subsequent argument (U622) about applying knowledge of bacterial structure to the selection of appropriate antibiotics, U586 was re-coded as an example of **resolution**, because it seemed M4 was genuinely thinking about what he needed to *learn* in order to understand an aspect of the scenario. Finally, there was just a single example of an aspect of cognitive presence in step 5: this was **integration** to another part of the *course*, when M4 suggested that notes from a previous teaching Block would be relevant.

7.4.2. Social presence.

Group Y1B3 demonstrated abundant **emotional expression** and **cohesion** throughout steps 1 to 4. However, there were **negative manifestations** of social presence, such as

when F4 referred to a dissection lab and was subsequently *teased* for saying '…did one of the cadavers die of pneumonia …?' (U27); the Facilitator later *teased* F4, calling her 'the bacteria detective' (U211). Occasionally, social presence impacted negatively on cognitive presence. Thus when F4 (U312) *joked* about the likely prevalence of pneumonia in a Scottish town perceived to have a large proportion of elderly people, this led to general *joking* and *interrupted* what had been a run of **external** and **internal exploration**.

7.4.3. Teaching presence.

Once more, there was clear evidence for teaching presence, and for this enabling cognitive presence. In one line of discussion about the causative agents for pneumonia (Appendix L), the Facilitator contributed soft scaffolding teaching presence, **facilitating development** and **understanding** and enabling the **trigger, external exploration**, **internal exploration**, **integration** and **resolution** aspects of critical thinking The Chair for this half of the tutorial, F4, had quite a facilitative style, providing soft scaffolding that directly enabled cognitive presence. For example, she **facilitated understanding** by asking this *question*:

> *…so the lungs become solid because…?*
>
> *F4, Y1B3T2, U100.*

This enabled M4 to demonstrate four aspects of critical thinking in a single utterance:

> *… of the cellular infiltrate. I think you can also get fluid accumulating in the pleural space ... So if you looked at someone's chest x-ray they might have fluid, if you were looking in the diaphragmatic recess.*
>
> *M4, Y1B3T2, U101.*

He demonstrated **external exploration** by providing a direct *answer* to the question; his *suggestion* that fluid may also contribute to the solid nature of the lungs in a patient with pneumonia constituted an example of **internal exploration**. He **integrated** *ideas* about the pathology of pneumonia and its diagnosis by X-ray imaging. Moreover, he demonstrated **resolution**, by *applying his knowledge* of the pathology of pneumonia to the diagnostic X-ray.

In step 3, when brainstorming risk factors for pneumonia , the students started listing the usual suspects, including drinking and smoking. The Chair **facilitated the process** by instructing the group to 'stop there' (U336), then **facilitated understanding** by *questioning* why these lifestyle factors might increase the risk of developing pneumonia. This led directly to **internal exploration** by her peer, F2, who *hypothesised* that drinking might suppress the cough reflex.

Hard scaffolding teaching presence also enabled cognitive presence. In step 2, a **resource** stimulated the **trigger** and **internal exploration** aspects of critical thinking: the *scenario* encouraged F2 (U46) to identify differential diagnosis as an *issue*, and she was able to *explain* which particular phrase in the scenario suggested this. In step 4, the **structure** afforded by the PBL *steps* and student *roles* enabled cognitive presence. When M4 said:

> *Pneumonia, signs, symptoms, blah blah blah, go through Kumar and Clark section on pneumonia and write down some notes… Discuss pneumonia, signs, symptoms, causes, risk factors ...*
>
> *M4, Y1B3T2, U518 & U52.*

F4 responded with: 'I'm … Chair and we're not having a dummy question' (U525). This was interpreted as **resolution** via *reflection on learning*, since it acknowledged and prevented a superficial approach to formulating questions.

7.5. Group Y1A3, Steps 6 &7 of scenario about thermoregulation and malaria.

7.5.1. Cognitive presence.

A fourth Year 1 group, Y1A3, discussed the scenario about thermoregulation and malaria. The evidence for cognitive presence in step 6 was very similar to that found for groups Y1C3, Y1B2 and Y1B3: namely, multiple indicators of **external exploration**, **internal exploration** and **integration**, with some **resolution**, but also instances of the **trigger** category, in the form of a recognisable *gap in knowledge*. A new indicator was identified for **internal exploration**: the use of an *analogy* to explain why prophylactic agents, or preventative treatments, do not prevent transmission of malaria. The analogy had a local flavour, referring to a Scottish bridge which was constantly being painted:

> *I don't think [Proguanil's] acting as a vaccine … it's not vaccinating you against [malaria] … it's like … painting the Forth Road Bridge, by the time you've … painted one end you have to start again, by the time you've immunised these people [and] disrupted gametocytes [in their bloodstream] they could be a bitten by … [another] mosquito … and the whole process can start again.*
>
> *M3, Y1A3T1, U440.*

There was little evidence for cognitive presence in step 7, other than **integration**, when students referred to a *lab* that supported the scenario; and linked to *experience outwith the course,* saying 'I had a whole lecture [from] my flatmate … because she went to Brazil and she didn't take any anti-malarials' (U501) .

7.5.2. Social presence.

All indicators of the **emotional expression** category of social presence were in evidence during this discourse, as were indicators of **cohesion**. In particular, there was

lots of *support for ideas* with students paraphrasing one another sufficiently to indicate they understood the point being made.

7.5.3. Teaching presence.

Very little in the way of soft scaffolding input was provided by this Facilitator. She **facilitated understanding** by *asking questions* about the sexual stage of the lifecycle of the malarial parasite and about the use of pharmacological agents for prevention and for treatment. However, several facilitative comments were made by students, such as this example of **facilitating understanding** by *providing clarification*:

> *… the central thermoreceptors are the most important in controlling body temperature, the peripheral ones … don't really … do a lot, they [are] mainly used for the sensation of heat and touch …*
>
> *M1, Y1A3T1, U8.*

In terms of hard scaffolding teaching presence, there were the usual references to the **structure** afforded by *PBL process*, but also many references to a wide variety of **resources**, including *books* (U32, U78, U107, U113, U117, U151, U230, U309, U405), *diagrams* explaining thermoregulation (U47) and the lifecycle of the malaria parasite (U175, U176, U258), the *scenario* (U141, U157, U362), a *lab* (U258, U264, U504), a *friend* (U501), *websites* (U334, U396, U473, U510, U512) and an online *article* (U461). It is unknown whether Group A3 always utilised such a variety of resources, because they regarded this PBL as atypical; M3 noted, 'it's a break from what we usually do' (U500). In one instance, the **resource** category of teaching presence interacted with cognitive and social presence:

> *… [regarding] prevention … I just think it's really interesting … there was a massive scheme in the sixties and seventies to try and alleviate [sic] malaria, there was an effort … by the WHO and they used so*

much DDT … and insecticides … it worked for a while but then they ... realised the problem was so huge they couldn't actually wipe it out.

M1, Y1A3T1, U473.

This was coded to the *information exchange* indicator of the **external exploration** category of cognitive presence; to the **resource** category of teaching presence, since M1 referred to a *report* by the World Health Organisation (WHO); and to the *personal perspective* indicator of the **emotional expression** category of social presence, since the student said that the material interested him. Because the WHO **resource** was consulted outwith the tutorial, it was not interpreted as enabling cognitive presence; rather, in his reference to the WHO report, M1 demonstrated **integration** by linking with *empirical evidence*.

7.6. Group Y1A3, Steps 1 to 5 of scenario about pneumonia.

7.6.1. Cognitive presence.

Group Y1A3 went on to address the scenario about pneumonia. The categories of cognitive presence identified in steps 1 to 4 were very similar to those identified for corresponding discourses. Note that Group Y1A3 did not complete step 5. In step 2, the **resource** category of teaching presence enabled the **internal exploration** aspect of critical thinking, when F3 *hypothesised* (U47) that pneumonia must affect the brain, because the patient in the *scenario* was confused. Also in step 2 was an example of **integration**, when F5 acknowledged (U31) that they had previously encountered the topic of bacterial structure on the *course*. In step 3, brainstorming, there were contributions that were initially regarded as **negative manifestations** of cognitive presence, since students said they would 'need to know [about different bacteria]' (M3, U98) and they would 'need to look at replication' (F5, U113). However, on reflection, it seemed these could be regarded positively, as examples of students realising that there was an aspect of normal biology that they needed to learn, in order to be able to

understand the scenario. These utterances were coded to the *reflection on learning/SRL* indicator for **resolution**. Nevertheless, in steps 3 and 4 there were indeed **negative manifestations** of cognitive presence, with M1 setting *limits on learning* by asking 'Do we need to know that?' (U350) and 'How much depth do we have to go into [on] this? Because pneumonia is a huge topic' (U453).

7.6.2. Social presence.

Again, social presence was evident throughout the discourse, with multiple indicators of **emotional expression** and **cohesion**. There were very few **negative manifestations**, with the occasional *lack of cohesion* and very minor *teasing.*

7.6.3. Teaching presence.

There was relatively little soft scaffolding; just a few instances of the *questioning* indicator for **facilitating understanding**. Some were from students: thus, in response to M3 saying that pneumonia and lung cancer could be co-morbidities (U185), F1 *questioned*, 'Why is that, why lung cancer?' (U186), which enabled the **internal exploration** aspect of critical thinking, via an attempted *explanation* from M3 (U187), that pneumonia can result in occlusion of vessels, with inadequate clearance of the lungs, which can encourage the tumour to grow. This is not clear; possibly, he meant there is blockage of blood vessels supplying the lungs, and that the hypoxic environment facilitates tumour growth. U187 therefore represented a **missed opportunity** for the Facilitator to encourage better articulation of M3's thoughts.

A further example of interaction between cognitive and teaching presence was:

> *if your immune system isn't working so well, … when you get cuts ….they are going to stay open for much longer and not heal as well, so that could predispose you to bacteria?*
>
> *F5, Y1A3T2, U263.*

This demonstrated **internal exploration** via *hypothesis formation*. It was followed by the Facilitator using a *question* to **facilitate understanding**, as well as making reference to the **resource** category of teaching presence. She asked (U264) if there was anything in the *scenario* that was relevant to F5's hypothesis. She was trying to encourage them to consider that the patient's cough reflex might be insufficient to afford protection for the airways. She *probed* further to **facilitate understanding**, by asking, 'Do you think the cough reflex is as strong in an older person? To expel sputum?' (U279). Although these were closed questions, they had the desired effect of enabling **external** and **internal exploration** in relation to the cough reflex.

Finally, the hard scaffolding categories of **structure** and **resource** were well-represented in this discourse, with references to the *steps, scenario, dictionary*.

7.7. Group Y2B3, Steps 6 &7 of scenario on bilirubin metabolism and viral hepatitis.

This discourse featured a group of second year students, whose learning objectives included a review of bilirubin metabolism; the hepatitis A, B and C viruses; the consequences of hepatitis infection; and the epidemiology, diagnosis, treatment and management of hepatitis. Note that Group Y2B3 did not actually address step 7.

7.7.1. Cognitive presence.

The evidence for cognitive presence was similar to that found in equivalent discourses featuring Year 1 PBL CoIs. Step 6 had examples of all categories of cognitive presence: **trigger**, **external exploration**, **internal exploration**, **integration** and **resolution.** Cognitive presence is discussed further in relation to teaching presence (7.7.3).

7.7.2. Social presence.

The **emotional expression** category of social presence was apparent, but there were relatively few instances. There were several examples of **cohesion**, through *support for*

ideas or *interpersonal support*. One example was when M1 gave the prevalence of hepatitis worldwide (U230). The Facilitator failed to hear the reference to worldwide and said this should be specified; other students immediately interjected that M1 had said this (F7, U238; F1, U239).

There was some **negative manifestation** of social presence: a *lack of cohesion* when the Chair tried to move the group on (F1, U227, U360) but her peers continued talking about the topic at hand (F4, U228; M1, U362). In fact, adherence to process was not very good. In the transcript of this discourse, it was difficult to identify the precise objectives being answered at any one time. Sometimes the *lack of cohesion* seemed to arise when the Facilitator *undermined the PBL process*, thus a negative aspect of teaching presence led to a negative aspect of social presence. When the students were discussing the second objective, about hepatitis viruses, the Facilitator pushed them for information about the immune response to the virus. The Chair said:

It's … covered in Question 3….We'll finish this before we [do that].

F1, Y2B3T1, U147, U149.

Similarly, when the group was discussing the consequences of hepatitis C infection, and F4 mentioned that 'interferon … is not really that effective' (U402), the Facilitator asked about interferon's function (U403), but the Chair, F1, said 'I think that's in Question 4 …' (U407). The Facilitator acknowledged they were 'jumping about' (U408), but rather than conceding to F1 and adhering to the PBL process, he pressed on: 'But since we've mentioned it, do you want to [discuss the role of interferon]?' (*ibid*). Arguably, he attempted to **facilitate understanding** by *probing*, but did so at the expense of *undermining the Chair* and *undermining the process*. F4 seemed to offer *support* to the Chair, demonstrating **cohesion**, when she said: 'What question do we still have to do before that?' (U412). From the video-recording, the Chair's body language indicated she was unhappy, perhaps because the Facilitator was interfering with her chairing. In overlapping comments, students said that the apparent jumping

about was due to the way information was presented in textbooks; this could be interpreted as *support* for F1's chairing. The conclusion may be drawn that the students in Group Y2B3 formed a cohesive CoI, with good social interactions, but there was tension between the group and the Facilitator, or at least between the Chair and Facilitator, and the process was less student-centred than for other groups in this study. It may be significant that there was no attempt to undertake the reflective step 7, this omission being a **negative manifestation** of teaching presence; if the group made a habit of neglecting this step, then problems with process, dynamic and/or learning might be expected (Katz, 1995).

7.7.3. Teaching presence.

There was considerable soft scaffolding teaching presence in this discourse. Utterances were coded to all three indicators for **directive** intervention: direct *answers*, *didactic* comments and *advice*. However, there were many indicators of the Facilitator or students **facilitating process**, **understanding** or **development**. There were also examples of hard scaffolding teaching presence, specifically **resources**. These categories are discussed below, in the context of complex interactions between elements of the adapted CoI Framework.

The group began by discussing bilirubin metabolism and F5 drew a *diagram* on the whiteboard. The Chair *asked*:

> *Is someone going to talk us through what [F5 is] drawing up?*
>
> *F1, Y2B3T1, U17.*

Here, F1 was **facilitating the process** and referring to a **resource,** illustrating interaction between soft and hard scaffolding teaching presence; and by encouraging one student to talk whilst another drew, she fostered **group cohesion**, thereby illustrating interaction of teaching and social presence. U17 directly enabled the **external exploration** aspect of critical thinking, as F3 *exchanged information* about

bilirubin metabolism (U19). She gave a fairly accurate account to the point where conjugated bilirubin is secreted from the liver as a constituent of bile, but then admitted to being unsure. This was coded to the **resolution** category of cognitive presence, since her recognition of uncertainty was interpreted as meta-cognitive experience (see 3.3.1), an aspect of *meta-cognition*. The complex inter-relationship between teaching and cognitive presence continued: F3 referred (U19) to three **resources**; she **facilitated understanding** by identifying *conflicting information* and by *seeking support* for her personal understanding; and she finished with the **external exploration** category of cognitive presence as she sought confirmation that urobilin is the same as stercobilin. F6 tried to **facilitate understanding** by *providing clarification* that 'urobilin is in the urine and … stercobilin is in the faeces'. (U21). F3 was still unsure 'if the words are used interchangeably' (U26) and effectively *hypothesised* this was the case, providing an example of **internal exploration**. F2 tried to help, saying 'In ….Baynes and Dominiczak, the biochemistry book, it has that …stercobilin is faecal urobilin' (U28); this was coded to all three elements of the CoI Framework, being interpreted as **cohesion** via *support*, and simultaneously as **external exploration** via *information exchange*, as well as demonstrating the **resource** category of teaching presence. In fact, stercobilin and urobilin are not identical; they are two different pigments, and the Facilitator intervened at this point, saying:

> *Yes, I think that's similar stories but not identical.*
>
> *Fac, Y2B3T1, U29.*

Here, he **facilitated development** by *providing support*, since he confirmed there is similarity between urobilin and stercobilin, but not identity. U29 was also a **missed opportunity** to probe further, but the students' subsequent utterances revealed an appreciation of functional differences between urobilin and stercobilin.

There followed a series of about fifty utterances in which the Facilitator tried to **facilitating understanding** by asking *questions* and *probing* about the biochemistry of

bilirubin conjugation reactions. Initially, this run of questions did not seem very positive, because the Facilitator was saying more than the students, who had been doing fine without his interventions; moreover, the level of detail he was pushing for reflected his academic discipline rather than the expectations of the teaching team. The Facilitator's style seemed to be more interrogative than facilitative. However, his questions were interspersed with utterances - albeit brief - that were generally coded as **external exploration** via *information exchange* or **internal exploration** by means of *explaining* or *offering suggestions.* So his interventions did constitute examples of teaching presence enabling cognitive presence.

By **facilitating development**, the Facilitator also enabled many instances of cognitive presence. He *provided support* for student contributions, either by giving a further example of what they had been talking about, or by summarising what they had been saying. For example, following a line of discussion about how viruses may be detected, he said:

> *So you could do three things, you [could] look for the antibodies that we have made [against the virus], . you could look for the [viral] proteins …., and … for the [viral] DNA.*
>
> *Fac, Y2B3T1, U204.*

A new indicator for **facilitating development** was *modelling* learning behaviour. Having asked if students had encountered the term *decompensated*, in relation to liver disease (U567), the Facilitator said 'As far as I can make out it just means that the [liver damage] has got out of control' (U573). Whether intentionally or not, he was *modelling* a socio-constructivist learning process, offering his limited understanding of a concept for critique and validation. He also *modelled* a lack of certainty, and it could have been valuable for students to appreciate that a member of academic staff experienced this. Moreover, his intervention enabled **external exploration**, as several students *exchanged information* and **integrated** information from a lecture they had earlier in

the *course*. Later, in a **negative manifestation** of cognitive presence, student F5 risked *limiting learning*, asking if they had 'to go in depth into the pharmacology' of anti-viral drugs (U693). The Facilitator **facilitated development** by *modelling* curiosity and **facilitated understanding** by asking a *question*:

> *No, it just seemed to be interesting, so … if we're going to find a drug that will stop viral replication, in general principle how might we go about it?*
>
> *Fac, Y2B3T1, U694.*

This enabled **internal exploration**, as students *hypothesised* that one could block the virus from interacting with its receptor (F4, U696) or target the viral enzymes required for replication (F5, U700).

Soft scaffolding teaching presence clearly enabled aspects of critical thinking. Hard scaffolding teaching presence also enabled cognitive presence. In describing the structure of hepatitis A, the use of a **resource**, the *whiteboard*, enabled **internal exploration** via *explanation*, **integration** to a *peer's comment*, and **resolution**, in terms of meta-cognitive experience, an aspect of *meta-cognition* (F6, U153). In discussing when viral infection is contracted, the *scenario* served as a **resource** and enabled **resolution** in the form of *reflecting on the consequences* of infection at different ages (F2, U312).

Occasionally, a **negative manifestation** of teaching presence impeded cognitive presence. For example, when F5 said '…bilirubin is bound to the albumin in the plasma…' (U86), the Facilitator *interrupted*:

> *But that's not a covalent bond, that's it just kind of being wrapped up inside the albumin.*
>
> *Fac, Y2B3T1, U87.*

His intervention *inhibited* the **external exploration** aspect of critical thinking, and it was also a **missed opportunity** to facilitate understanding by asking F5 to explain what sort of interaction she meant, when she said bilirubin was bound to albumin.

7.8. Group Y2B3, Steps 1 to 5 of scenario on gallbladder and liver function.

Group Y2B3 went on to complete steps 1 to 5 of a scenario featuring a patient with obstructive jaundice.

7.8.1. Cognitive presence.

All five categories of cognitive presence were identified in this discourse and, again, the pattern varied according to the step of the PBL process. In particular, there was abundant evidence for cognitive presence in step 3, brainstorming, with uninterrupted runs of **external exploration**, **internal exploration** and **integration**. For example, F4 said that in the dissection lab she had noticed that different cadavers had different-sized gallbladders (U203), thereby **integrating** the topic of discussion with another part of the *course*. F6 said the gallbladder '… felt like a stress ball' (U204), an example of **internal exploration** by making an *analogy*; whilst F4 *hypothesised* that the gallbladder 'mustn't be very expandable if it can't let stones pass…' (U205). F1 demonstrated **integration** by linking to her *peer's comment*, as well as **internal exploration** by *explaining* that there's only liquids going through usually' (U206). In step 4, formulating questions, F5 commented that this was the third time they had encountered the enterohepatic circulation (U408), hence **integration** with previous parts of the *course*. Cognitive presence is discussed further in relation to teaching presence (7.8.3).

7.8.2. Social presence.

There was evidence for the **emotional expression** and **cohesion** categories of social presence. In reading the PBL scenario, the Chair for this half of the tutorial, F6, stumbled over the name of an enzyme, gamma glutamyl-transferase (U8). The

Facilitator corrected her. F1 asked 'Do they generally use the whole name or do they just call it Gamma GT?' (U13). The Facilitator acknowledged this was the case and F6 added, 'the doctors say Gamma GT' (U15). It did seem that the students were *supporting* one another in reacting against the Facilitator's enthusiasm for using full biochemical names. This, in conjunction with the tension between the Facilitator and Chair for the first half of the tutorial, F1, suggests some negativity towards this Facilitator. One might expect this would impact negatively on the social environment.

7.8.3. Teaching presence.

The pattern of teaching presence in this discourse was very similar to that in the other discourse featuring Y2B3. That is, the Facilitator provided soft scaffolding in the form of **directive** contributions, with all three indicators in evidence; he **facilitated development**; both he and the students **facilitated understanding**; and the students tended to **facilitate the process**, whereas the facilitator often *undermined* it, in a **negative manifestation** of teaching presence. There was also hard scaffolding teaching presence, with **structure** represented by the *steps* and r**esource** represented by the *scenario*. Complex relationships between these categories of teaching presence and other elements of the CoI Framework are discussed below.

In step 1, defining terminology, F4 **facilitated understanding** by *seeking support* for her grasp of the biochemical function of Gamma GT, recounting what she knew about the enzyme; the video-recording showed the Facilitator nodding whenever she was correct: silent scaffolding (Carter *et al*, 2006). He **facilitated development** by *providing feedback* to F4, but simultaneously *undermined the PBL process*, a **negative manifestation** of teaching presence, since this lengthy exchange was not appropriate in step 1. F4 realised this (U28): in an example of teaching presence enabling social presence, the **structure** afforded by the *steps* encouraged her to *co-operate* and restore group **cohesion**. Unfortunately, the Facilitator continued to impact negatively on the process and group cohesion by being **directive,** giving information about Gamma GT.

In response, the Chair looked directly at the scribe, M1, and stated a main issue, effectively *interrupting* the Facilitator but thereby **facilitating process**.

Step 3, brainstorming, began with F4 offering to draw a diagram of the gallbladder, which rendered the Scribe temporarily redundant; he made a *joke* of this, saying he'd just stand in the corner (U67), which led to extended *joking*. Thus the **resource** category of teaching presence led to positive and negative aspects of social presence, enabling **emotional expression**, but also a **negative manifestation**, namely *lack of cohesion*. F2 tried to **facilitate the process** and get them back on track, asking if they were talking about normal bile production (U71), but the Facilitator was more successful when he encouraged the group to list the components of bile (U77).

As with step 3 in equivalent discourses, there were plenty of examples of teaching presence enabling aspects of critical thinking. Using a **resource**, a *diagram* on the whiteboard, enabled F5 (U228) to **facilitate understanding**; she described that in patients with obstructive jaundice, bile is produced as normal but gets backed up because of a blockage. This was not coded as explanation because her intonation made it clear she was *seeking support* for her understanding. However, she went on to demonstrate **internal exploration** when she *hypothesised* why such patients would have high levels of bilirubin. A further example was seen in a line of discussion about treatment of obstructive jaundice. This was stimulated by F1's *question* (U261), **external exploration**, about the purpose of cholecystectomy, which is removal of the gallbladder. By being **directive** and **facilitating development** through *providing support*, the Facilitator enabled several instances of **internal exploration** via *hypothesis formation*. He again **facilitated development**, confirming:

> *… we don't want [stone formation] to happen again … it was the concentration [of bile] within the gallbladder that was the problem … if we take her gallbladder out dilute bile will trickle out all the time…*
>
> *Fac, Y2B3T2, U275.*

In Step 4, formulating questions, there was further soft scaffolding by the Facilitator, who gave **directive** *advice* about the focus and depth in relation to specific objectives. There was evidence of teaching presence enabling aspects of critical thinking: thus the *scenario*, a **resource**, prompted **internal exploration** by F6, who *suggested* they 'should always make reference to the liver function [tests] …' (U477); whilst F1 demonstrated **resolution**, *applying her knowledge* of the frequency with which liver function tests had featured in PBL, to conclude 'we can assume it's important' (U479).

Negative manifestation of teaching presence resided mainly in *omission* of step 5; and in *undermining the PBL process*. Often the Facilitator was responsible for the latter, but sometimes students were. For example, during step 2, on hearing the suggestion of gallstones as an issue, F5 (U39) and F4 (U40) strayed into brainstorming, **integrating** their experience of cadaver dissection earlier in the *course*. Also, F1 demonstrated **external exploration**, *seeking confirmation* about the reason for pale stools (U43), further *undermining the PBL process*. One wonders if students' failure to adhere to the process was related to the negative example provided by the Facilitator.

7.9. Group Y2C3, Steps 6 &7 of scenario on viral hepatitis.

A second group of Year 2 students debriefed about viral hepatitis, but not bilirubin metabolism; possibly, they decided they had addressed this sufficiently on previous occasions.

7.9.1. Cognitive presence.

There was evidence for all five categories of cognitive presence within step 6. For example, F3 demonstrated **external exploration** via *information exchange*, and **internal exploration** via *exemplification*, saying Hepatitis A is 'spread by the faecal/oral route and poor sanitation and hygiene, like not washing your hands or else food being washed with contaminated water' (U11). An example of **resolution** via *reflection on learning* was:

[The lecture was good] because he kept the same format for each virus, so went through … HepA … this is what it looks like, this is how you diagnose it, and then HepB.

F1, Y2C3T1, U177.

Cognitive presence is discussed further in relation to teaching presence (7.9.3).

7.9.2. Social presence.

The social presence in this CoI was positive, with examples of **emotional expression** and **cohesion**. There was almost no **negative manifestation** of social presence. In one example of a digression that impacted negatively on cohesion, the student eventually realised and finished with: 'that was a diversion there, sorry' (F4, U186).

7.9.3. Teaching presence.

Soft scaffolding teaching presence was evident. The Facilitator for Group Y2C3 was closest in style to the Facilitator of Group Y1C3, who featured in Chapter 6. They both made relatively few interventions, often using anecdotes to *provide support* for ideas, thereby **facilitating development**. The Facilitator of Y2C3 also did this by *modelling* good learning behaviour (U109, U111, U116). However, there were several **missed opportunities** to enable cognitive presence. Some of his interventions were simultaneously regarded as positive and negative manifestations of teaching presence. For example, when F2 explained that '… you can get over your jaundice and then you can get [it] again …' (U19), the Facilitator related an anecdote about his experiences on a cycling trip in New Zealand, where one of his companions contracted hepatitis and kept getting recurrences, which the Facilitator said was 'the effect of taking alcohol' (U20). So he **facilitated development** by *providing support* for the idea that one can get recurrent - or chronic - hepatitis, and he hinted at one reason; but this was a **missed opportunity** to ask why alcohol consumption might lead to chronic hepatitis, or to get

students to hypothesise about other possible explanations. The Facilitator did occasionally **facilitate understanding** by asking a *question*. For example:

> *Has anyone any idea why in the case of HepB they check for your [immune] response but they don't with HepA…*
>
> *Fac, Y2C3T1, U107.*

In this case, teaching presence enabled an aspect of critical thinking, **internal exploration**, since F1 *hypothesised* (U108) it was because there were typically people who failed to respond immunologically to hepatitis B infection, unlike the case with hepatitis A. F2 *hypothesised* further that 'maybe [with] HepA you get over it and it doesn't become chronic …' (U110). They were on the right lines: some people fail to mount a sufficient immune response to hepatitis B; without vaccination, they are at risk of chronic hepatitis and consequent liver damage. Another example of teaching presence enabling an aspect of critical thinking was where the Facilitator's *question* about the role of interferon (U159) **facilitated understanding** and led to the **trigger**, **external exploration, internal exploration** and **integration** aspects of cognitive presence. For example, this *explanation*:

> *The key thing is that [interferons] induce the cell's enzymes so that the cell inhibits transcription or translation [of] the viral [genome]…*
>
> *F1, Y2C3T1, U163.*

The Facilitator encouraged the group to engage with the **structure** of the PBL process: specifically, to complete *step* 7. He thereby **facilitated the process**, demonstrating interaction between hard and soft scaffolding teaching presence. This enabled several aspects of critical thinking: **external exploration**, **integration** and **resolution**. An example of resolution was *reflection on learning*:

> *I found it strange that there was a change of direction, we'd been looking at all this physiology and biochemistry and all of a sudden it's … infectious disease.*
>
> *F4, Y2C3T1, U263.*

In step 7, soft scaffolding manifest as **facilitating development** by *facilitating reflection*, when the Facilitator's comment about the importance of hepatitis (U265) directly enabled the **resolution** aspect of critical thinking, as well as the **emotional expression** category of social presence, as F2 reflected on the incidence of hepatitis:

> *That's what I was thinking, especially …with the drug users in [the city] … it's quite frightening to know that 75% of intravenous drug users [have the disease].*
>
> *F2, Y2C3T1, U266.*

In this discourse, there was relatively little evidence for hard scaffolding teaching presence, with only one or two examples of **resource** or **structure**. This may have reflected the fact that (i) the students were not talking about physiological processes or anatomical structures, so they had no reason to draw a flow *diagram* or a schematic diagram; and (ii) rather than follow the *PBL process* and address each of their objectives in turn, the students had agreed at the outset that they would 'feed back all of HepA and then HepB and HepC' (F1, U2).

7.10. Group Y2C3, Steps 1 to 5 of scenario on gallbladder and liver function.

Group Y2C3 then completed steps 1 to 4 of the PBL scenario featuring a patient with obstructive jaundice.

7.10.1. Cognitive presence.

In step 1, evidence for cognitive presence was limited to some instances of **external exploration**, when students *exchanged information*, *asked questions*, *sought clarification* or *sought confirmation*. Step 2 additionally had examples of the **trigger** category of cognitive presence. There was also some **internal exploration**, which occurred when students were trying to decide whether fat metabolism and fat digestion were relevant learning issues. M2 *suggested* they should just look at digestion, *explaining* that 'metabolism wouldn't really involve bile, would it?' (U63). As with other groups, the brainstorming step provided evidence for all five categories of cognitive presence, whilst in step 4 there was evidence for **external exploration**, **internal exploration** and **resolution**. Cognitive presence will be discussed further in the context of its interaction with teaching presence (7.10.3).

7.10.2. Social presence.

There were many indicators for the **emotional expression** and **cohesion** categories of social presence in each of steps 1 to 4. **Negative manifestations** of social presence were few. They occurred when the Facilitator *teased* the Scribe about needing 'to stand on a chair' (U135); when F3 *teased* F1 about the correct number of carbons in cholesterol (U155); when the Facilitator *teased* F3 about yawning 'on camera' (U368); and one example of a *lack of cohesion*, when M2 disagreed (U380 and U381) with F3's suggestion that chylomicrons were involved in emulsification of fat.

7.10.3. Teaching presence.

There was evidence for teaching presence throughout this half of the tutorial, but particularly during step 3, the brainstorm. Soft scaffolding manifest in the many examples of **facilitating process**, from the Facilitator and from students. The Facilitator made many more interventions in this half of the tutorial, many of them **facilitating understanding** or **development** (Appendix M). He used a strategy that was also

identified retrospectively in the equivalent discourse featuring Group Y1C3: he **facilitated understanding** by *encouraging integration*, helping students to make links with previous learning.

In some cases, his interventions enabled cognitive presence. For example, in response to a statement by F4 (U115), he **facilitated understanding** by *questioning* whether bile salts and bile acids were 'the same thing?' (U117). This directly enabled several indicators for **external exploration**, beginning with the following *information*:

> *Acid is the salt with a metal of … sodium ...in general that's what's an acid [is]...*
>
> *F1, Y2C3T2, U121.*

F2 *questioned* whether 'the salt [is] still acidic or … an alkali?' (U122). F1 followed with *seeking confirmation*: 'Aren't salts neutral?' (U124). M2 *answered* in the affirmative (U125) then contradicted this, saying 'buffers tend to be salts which have got a slight pH to one side or another [of neutral]'. In an example of **internal exploration**, F4 *hypothesised* that bile salts and bile acids were 'just ... different names for the same thing...' (U129). In fact, they are not the same. Bile salts are more amphipathic than bile acids and hence better detergents; only bile salts are found in bile. Note that the Facilitator did not provide this information; he hinted (U117) that bile salts and bile acids were not the same and I would expect him to have ensured the students returned to the topic and clarified things in the subsequent debriefing.

Hard scaffolding teaching presence included **structure**, in terms of the *steps*; and **resource**, with reference to the *scenario* in steps 1 and 3, and to *textbooks* in steps 2 to 4. There were a few **negative manifestations** of teaching presence, including being negative about the *usefulness* (M3, U97) or *availability* (F4, U201) of a resource.

In one instance, the Facilitator's *question*, 'Why do you need a gallbladder?' (U228), should have **facilitated understanding** and stimulated aspects of critical thinking, but

F2 said flippantly, ‘Because it’s nice … it’s a pretty colour’ (U230, U232), which caused *laughter*. Thus U228 led to **emotional expression,** as well as to **a negative manifestation** of social presence, namely *lack of cohesion.* But the Facilitator persisted in **facilitated understanding** by identifying the *conflicting information* that rats do not have a gallbladder (U233).

This concludes the analysis and interpretation of individual discourses. In this Chapter, we saw similarities between those discourses featuring steps 6 and 7 of the PBL process, and between discourses featuring steps 1 to 5, particularly in the way critical thinking manifest. Differences resided mainly in the way in which teaching presence manifest. Instances were seen where any one element of the CoI Framework impacted on another. In particular, there was unequivocal evidence for teaching presence enabling aspects of critical thinking.

Chapter 8. Cross-cutting themes: critical interpretation of findings.

In this chapter, cross-cutting themes from the findings are critiqued in relation to the original research questions (see 4.4.2).

8.1. Evidence for critical thinking in the PBL context.

8.1.1. Critical thinking as an individual or community activity?

The first research question asked to what extent critical thinking is demonstrated by students participating in PBL tutorials in the early years of a Scottish medical curriculum. Critical thinking, as viewed from a socio-constructivist, CoI perspective, is seen in this context. Aspects of critical thinking, equivalent to categories of cognitive presence, were identified in each discourse, for each group in this study. Generally, there were indicators for all five categories of critical thinking in each discourse, regardless of the students' year of study, the facilitator, or the scenario being addressed. However, individual utterances were typically coded to a single aspect of critical thinking. There were exceptions: for example, a first-year student demonstrated internal exploration, integration and resolution in a single utterance (F4, Y1C3T2, U58); another demonstrated external exploration, internal exploration and resolution (F3, Y1B2T1, U96); but there was no instance of any student demonstrating all five aspects of critical thinking in a single utterance. Thus, critical thinking in its entirety was a function of the CoI, the PBL group, rather than an individual within that community.

Within the various discourses, there were often lengthy periods where several students contributed utterances coded to the external exploration, internal exploration and/or integration categories of cognitive presence, with no examples of the trigger or resolution categories. Thus there was no sense of individual students, or the CoI as a whole, moving progressively through the five stages of critical/reflective thinking (Dewey, 1933; Garrison 1991, 1992) incorporated in my adaptation (see 3.4) of the CoI Framework (Garrison *et al*, 2000). Even in the context of faculty-moderated

asynchronous online tutorials, which are potentially more structured than face-to-face PBL tutorials, Garrison *et al* (2001) did not find students working methodically through the stages of critical thinking; rather 42% of postings were coded as exploration - an amalgamation of my external and internal exploration - with a further 13% coded as integration. Using a different coding scheme, Basu Roy and McMahon (2012) found a preponderance of problem description and problem exploration, equivalent to external and internal exploration. The relative difficulty in identifying the trigger and, especially, the resolution categories of cognitive presence are discussed further in 9.1.3.

8.1.2. Contribution to critical thinking by individuals in the CoI.

Individual members' direct contribution to critical thinking by the CoI was not an original focus of this study, but relevant findings were uncovered. Some students were more commonly found to engage in certain aspects of critical thinking. For example, in Group Y1C3, students F3, M3, F1 and F4 respectively suggested three, two, one and a further one of the issues for brainstorming, whilst the remaining four students suggested none, reflecting greater or lesser contributions to the trigger category; to know if this was typical, one would need to monitor the group over time. Some students made utterances that included multiple aspects of critical thinking: for example, in Group Y1B3, M4 demonstrated external and internal exploration, integration and resolution in a single utterance (U101). One question is whether some students were better at critical thinking than others. Theoretically, this might be assessed by the frequency of their utterances coded to aspects of critical thinking; or by computing critical thinking ratios (Basu Roy & McMahon, 2012; Kamin *et al*, 2001, 2003; Newman *et al*, 1995). However, such approaches are inconsistent with an interpretivist approach. An alternative is to consider patterns of contribution and/or the qualitative nature of utterances by individuals. Tabulating contributions by individual students revealed substantial differences in the volume of contributions, but, more importantly, in the pattern or nature of these. For example, in Group Y1B2, M1 made very few contributions, although he made at least one utterance coded to each aspect of critical thinking, other than trigger. In contrast, M3 was the greatest male contributor in Y1B2

in terms of volume, but also in terms of the sheer variety of indicators for the various categories of cognitive presence in his utterances, which was interpreted as a qualitative indicator of good critical thinking ability. For example, he demonstrated integration by making links between ideas, to parts of the course, to peers' comments, to prior knowledge, to empirical evidence and to experience outwith the course.

Some students contributed negative manifestations of critical thinking, generally by placing a limit on learning. For example, in Y1B2, M4 talked about having 'covered' (Y1B2T1, U167) material already; in Y1B3, F4 said that if students knew the contents of a particular recommended textbook, they were 'fine and sorted' (Y1B3T1, U321). Her peer, M4, openly admitted not learning the malarial parasite's life-cycle, seeing this as irrelevant, since he was not aiming to become a zoologist. This may be considered strategic. Such apparently negative contributions to cognitive presence must be appreciated in the context of the professional focus on outcomes and high-stakes exams (Pardales & Girod, 2006), which is not to say they should go unchallenged. In step 7, reflection on performance, this same student said the resources he used were inadequate and left questions unanswered (Y1B3T1, U320), but he gave no indication of what he would do to resolve these, contrary to expectations of self-directed learners (Schmidt, 2000), in particular their self-management of resources (Garrison, 1997). However, the importance of contextual, interpretivist coding was illustrated in relation to this student, M4: during the brainstorm in a second PBL scenario, he asked if they needed to 'cover' (Y1B3T2, U586) bacterial structure. This was originally interpreted as a negative manifestation of cognitive presence, but from a later contribution it was appreciated that he had been trying to determine if the group needed to understand bacterial structure in order to understand the mechanism of anti-bacterial drugs.

8.1.3. Aspects of critical thinking in specific steps of the PBL process.

Aspects of critical thinking were associated with each step of the PBL process. Given the nature of this study, it would have been inconsistent to consider the frequency of indicators for different aspects. However, there was substantially more evidence for

various aspects of critical thinking in steps 3 (brainstorm) and 6 (debrief) of the PBL process, as evidenced by the variety of indicators. Thus in step 3, internal exploration was likely to be evidenced by hypothesis formation, explanation, offering alternative perspectives or suggestions, exemplification and providing analogies; whereas in other steps of the PBL process, perhaps just one or two of these indicators would be identified.

In step 6 of the PBL tutorial, CoI members bring the fruits of their independent research back to the group, for verification via discourse (Garrison, 1992). Students would presumably have integrated and applied new knowledge during their independent research to address the PBL objectives, but articulation of knowledge constructed outwith PBL would appear within the tutorial to be straightforward exchange of information. Yet integration and resolution were seen in step 6, as CoI members tried to integrate peers' contributions into their personal knowledge constructions (Van der Vleuten *et al*, 2000), and as they reflected on the consequences of information provided by peers.

As expected, utterances in step 2, identifying learning issues, were generally coded to the trigger category of cognitive presence. Steps 5 and 7, respectively where students identified resources and reflected on the group dynamic and performance, were frequently omitted or trivialised, which is a pity, since they offered opportunities for students to justify their use of resources, or critique these; and to engage with meta-cognitive aspects of critical thinking. Indeed, those groups which did engage with step 7 - Y1A3, Y1B2, Y1B3, Y2C3 - all demonstrated some aspect(s) of critical thinking during that step.

8.2. Evidence for social presence in the PBL context.

The second research question asked to what extent social presence and teaching presence were in evidence during PBL tutorials in the featured Scottish medical curriculum. There was evidence for social presence in all twelve discourses investigated.

In particular, emotional expression, as humour, featured strongly in all tutorials, being seen throughout the PBL process. There was relatively more emotional expression during steps 1 to 5 of the PBL process, than during steps 6 and 7. In step 6, when students were focused on sharing and thereby validating their knowledge from independent research, they may have taken this more seriously and been disinclined to joke.

There were relatively few explicit indicators of open communication: occasionally, students made negative comments about parts of the curriculum, seemingly unfazed by the presence of the facilitator or the camera; and Group Y1C3 teased their facilitator, showing they were uninhibited in the setting of the PBL tutorial. The pervasive humour indicated that students generally felt safe in the PBL environment. It may be assumed they felt able to communicate openly and test their thinking in the expectation of fair critique. Social presence also manifest as group cohesion, indicators for which included collaborative comments, co-operative comments, re-iteration for the benefit of a peer, inter-personal support, and support for ideas. Occasional negative manifestations of social presence included a lack of cohesion; for example, when the teasing dynamic between two individuals in Group Y1B2 threatened the critical nature of the discussion.

Although the categories for social presence in this study were the same as those used by Garrison *et al* (2000), and although they were identifiable in, and hence relevant to, the PBL context, they were likely measuring subtly different constructs. In the asynchronous online environment, particularly in the early years of this century, when Garrison and co-workers initially applied their framework, online communication was text-based, and social presence reflected the ability of community members to project their personalities into the text-based online environment (Garrison *et al*, 2000, 2010). The use of emoticons (Garrison *et al*, 2000, 2001) was taken as proxy for emotional expression, a category subsequently rebadged as effective communication (Garrison, 2007). In contrast, in the PBL discourses in this study, there was direct evidence for emotional expression, in the form of jokes, laughter and statements of feeling.

Research into online CoIs has shown that the nature of social presence within a CoI may change over time (Swan, 2002, 2004). Garrison (2007) has suggested that in the initial stages, establishing personal relationships is important, but group cohesion in the CoI requires a focus on the intellectual task. Swan's findings may have limited application in face-to-face environments, where working relationships may be established relatively quickly and easily. Nevertheless, when the PBL CoI first comes together the facilitator should help establish a good social environment, to facilitate discourse and hence aspects of critical thinking; whilst ensuring that personal relationships and fun do not impair the inquiry.

8.2.1. Contribution to social presence by individual student members of the CoI.

Analysis revealed interesting variation in individual contributions to social presence. For example, in Group Y1B2, M1 made no utterances coded to social presence; he made few other contributions, and it is tempting to speculate whether he was isolated in the group, and whether there was a cause-and-effect relationship between any feeling of isolation and his limited contribution to cognitive presence. In the context of online tutorials, Swan and Shih (2005) found a strong correlation between students' positive perception of the learning environment, and their personal contribution to social presence. In the present study, there was no attempt to measure student perception of the learning environment, which can only be inferred from their personal contribution to social presence. M1's peers contributed more, and more varied, indicators of social presence in the brainstorming half of the tutorial. This is consistent with this part of the PBL process being relatively non-judgmental and relaxed, since there is relatively less expectation that students will know the material. It has already been noted (see 7.2.2) that in Group Y1B2, F3 was a particular contributor to negative aspects of social presence in this group, and the interaction between F3 and M3, and to a lesser extent others in the group, suggested a poor group dynamic. Yet these students also made positive contributions to social presence, and cognitive presence was readily identifiable in discourses by group Y1B2. As proposed in 7.2.2, perhaps if the overall balance in the

social environment is positive, a cohesive approach ensues, which enables aspects of critical thinking.

8.2.2. Contribution to social presence by individual facilitators.

Interestingly, there was variation in the social presence contributed by the facilitators in this study. The female facilitators of Groups Y1B2 and Y1A3 made almost no personal contributions to social presence, in terms of their utterances, although from the video-recordings their tone was friendly and supportive. As discussed, Group Y1B2 had some issues with the group dynamic; possibly, their Facilitator did not wish to encourage the jokers in the group by joining in. Alternatively, given that both she and the facilitator of group Y1A3 had been with their respective groups for a few weeks, it is possible that having established a comfortable social environment early on, they now chose to focus on the scaffolding aspect of their role. The male facilitator of Year 2 Group B3 also made minimal contribution to social presence in terms of utterance: literally just three or four in the two-hour tutorial were coded to social presence. Nevertheless, this facilitator had a substantial personal presence in terms of the volume of his contribution, since he contributed about 25% of the discourse in the first half the tutorial and 23% in the second half (discussed further in 9.4). The female facilitator of Group Y1B3 made some direct contributions to social presence, joking or gently teasing group members, and this did not seem to undermine the social environment, or cognitive presence (see 8.4). The male facilitator of Group Y2C3 made just a few direct contributions to social presence, in terms of utterances; however, his style of facilitation included personal anecdotes that facilitated development. The personal nature of the teaching presence contributed by this facilitator may have enhanced the social environment and contributed indirectly to social presence with the CoI. The same was true for the facilitator of Group Y1C3; moreover, he made quite a few utterances that were coded directly to the emotional expression category of social presence. As noted in 6.3.3, this facilitator joined in with the joking to the extent that he impaired critical thinking and had to refocus the group on the task. Nevertheless, Group Y1C3 was generally quite disciplined; so much so that it was not apparent from the transcribed discourse when the facilitator temporarily exited

the room. At that point, Group Y1C3 demonstrated real cohesion in the sense of being wholly focused on the intellectual task (Garrison, 2007).

8.3. Evidence for teaching presence in the PBL context.

There was substantial evidence for teaching presence in all twelve PBL discourses, but the way in which this manifest varied between them, apparently reflecting the specific style of the facilitator, the facilitative behaviour shown by particular students, and/or the scenario being addressed. Soft and hard scaffolding teaching presence was evident.

8.3.1. Soft and hard scaffolding teaching presence.

Soft scaffolding teaching presence was abundant in all discourses. Interventions that facilitated understanding, such as asking for clarification of meaning, asking probing questions, or identifying conflicting information, were sometimes provided by facilitators and sometimes by students. On the other hand, interventions that facilitated students' development were generally provided by the facilitator and directive interventions were always made by the facilitator. Facilitating the PBL process was generally a function of the student chair, but sometimes the facilitator or another student fulfilled this role.

Hard scaffolding teaching presence was also found in all discourses. Specific indicators tended to feature in specific steps of the PBL process. Thus whilst the resource category of teaching presence was identified in all seven steps for most groups, in step 1, the resource referred to was likely to be a dictionary; in step 2 it was likely to be the scenario, as students scanned this to identify learning issues; whilst in step 3 students would refer to diagrams on the whiteboard. The structure category of teaching presence was mainly used if students or their facilitator referred to the steps of the PBL process.

8.3.2. Manifestations of teaching presence in specific steps of the PBL process.

Teaching presence was distributed differently throughout the seven steps of the PBL process. Review of the categories present in each step, for each discourse (Appendix J) revealed broad patterns. In step 1, definitions, teaching presence tended to manifest as hard scaffolding, that is, structure and resource; as well as soft scaffolding aimed at facilitating process. The same was largely true of step 2, identification of learning issues.

In step 3, the brainstorm, all categories of teaching presence were evidenced, including structure and resource; directive input; and facilitating process, understanding and development. Despite this, there were proportionally fewer instances of teaching presence in the brainstorming step, relative to cognitive presence; there were often runs of utterances indicative of cognitive presence, interspersed with occasional indicators of teaching presence. Often, an aspect of teaching presence would precede sustained discourse between students, whose utterances would code to aspects of critical thinking. Sometimes consecutive comments were alternately coded to teaching and cognitive presence, which potentially reflected a disproportionate level of intervention by the facilitator, as for Year 2 Group B3; or relatively superficial questions asked by the facilitator that were answered in a single word or phrase, such as one facilitator's question related to the categorisation of pneumonia (Y1A3T2, U171); or instances where students initially gave a superficial or partial response to a question and the facilitator continued to probe, such as in the discourse with Group Y1B3, where the facilitator used this technique on a few occasions (Y1B3T2, U160 & U162; U175 & U177; and U180, U183 & U186). Note that in steps 1, 2 and 4 of the PBL process, indicators of teaching presence were more likely to be interspersed with indicators of social presence, which suggests that PBL CoIs particularly focus on the intellectual task during the brainstorm, in this half of the tutorial.

In step 4, teaching presence manifest as hard scaffolding, with structure being contributed by the formulation of researchable objectives and resource contributed by

accurate recording of those objectives on the whiteboard, as well as by reference to the scenario to focus questions appropriately. Soft scaffolding teaching presence in step 4 included multiple indicators for facilitating process, consistent with, for example, the chair or facilitator prompting the CoI to word a question; or re-iterating or summarising a question in a bid to move the process on (Fac, Y1B2T2, U735). Directive input from the facilitator commonly featured in this step, consistent with explicit advice about the focus or wording of questions. Facilitating development also featured, reflecting, for example, feedback to the group that their suggestions were appropriate (Y2C3T2, U686, U701). In step 4, there was little in the way of facilitating understanding, with only occasional examples, indicated by a student confirming their understanding (F4, Y1C3T2, U645, U647 & U649), or providing clarification (F1, Y2B3T2, U370), although this latter example related to a digression about coursework.

Where CoIs engaged with step 5, soft scaffolding was generally absent, but there was evidence for hard scaffolding. Unsurprisingly, this was mainly via reference to resources to address PBL objectives, consistent with the purpose of this PBL step.

In all six discourses featuring step 6, sharing information from independent research, there was considerable evidence for the facilitator or students facilitating understanding, with all discourses including a variety of indicators for this category: providing clarification (F3, Y1B2T2, U46; F4, Y1B3, U210), identifying conflicting information (F1 Y1B2, U488; F1, Y2B3, U261; Fac, Y2C3, U233), asking questions (F6, Y1A3T2, U186; Fac, Y1A3Y2, U271; Fac, Y1C3, 437; Fac, Y2C3T2, U117), probing for understanding (Fac, Y1B3, U71; Fac, Y2B3, U98; Fac, Y2C3, U270), and students seeking support for their own understanding (F4, Y1B2, U170; F4, Y2C3, U160). This emphasis on facilitating understanding is expected, since the purpose of step 6 is to allow students to share and thereby validate and reconfigure their constructions of knowledge (Van der Vleuten *et al*, 2000).

In all six discourses featuring step 6, there was evidence of the facilitator providing support and thereby facilitating development, a novel category in this adaptation of

Garrison *et al*'s (2000) CoI Framework. This support took the form of confirmatory nods (Y2B3, U27), hence silent scaffolding (Carter *et al*, 2006); anecdotes (Y1C3, U13; Y2C3, U20, U42 & U168); summarising students' contributions, implying they were correct (Y2B3, U204); giving didactic information that built on students' contributions (Y1A3, U100); or asking questions that referred to students' contributions and encouraged elaboration (Y1B2, U140; Y1B3, U97, U298). Other indicators of facilitating development were mainly seen in those discourses featuring Year 2 groups. They included feedback to the group (Y2C3, U343) or individual (Y2B3, U262), promoting meta-cognition or self-directed learning (Y2B3, U322), and role-modeling such characteristics as uncertainty (Y2C3, U109) or personal construction of knowledge (Y2B3, U573).

The variety of indicators used by facilitators of Year 2 PBL groups to facilitate development could be explained by them having the relevant scientific expertise and/or confidence to give feedback and support. The facilitator of Y2B3 was inclined to use his expertise to make corrections or be directive. In contrast, the facilitator of Y1C3 had content expertise for the scenarios he was facilitating, even joking that he would tailor his forthcoming supporting lecture to suit the group' objectives; but his contribution to facilitating development was limited to anecdotal support for their ideas. The issue of content expertise has been much-discussed in the PBL literature. It is generally accepted that expertise in facilitation is more important than content expertise (Gilkison, 2003), but that it is ideal to have both, provided that content expertise is used appropriately, to recognise when students have misunderstandings, and to use facilitation skills to help them realise and address this. Where facilitators have content expertise, their pedagogical stance (Wilkie, 2004) may influence how they utilise that expertise; that is, how comfortable they are with relinquishing a teacher-centred approach.

The category of facilitating process was ubiquitous in discourses featuring step 6. This is unsurprising, because one might expect there would be a need to move the students on through their answers to each objective. Finally, hard scaffolding teaching presence was always seen in step 6. Structure was generally indicated by reference to the PBL process

and working through the set questions. Resource was generally indicated by reference to textbooks or other sources of information, or by application of information to the scenario.

Not all groups engaged with the final reflective step of the PBL process, but where they did, teaching presence was mostly in the form of facilitating process, consistent with the facilitator or chair most likely having to press students to engage with step 7; anecdotally, students are inclined to omit this. There were also some examples of facilitating development by encouraging reflection (Y1B2, U290; Y2C2, U265).

Some manifestations of teaching presence were coded as negative, given their impact on critical thinking. In the main, these took the form of missed opportunities to enable critical thinking, which was particularly evident in steps 3 and 6; this was in spite of the fact that these two steps already provided much of the evidence for aspects of critical thinking. Other negative manifestations included utterances that undermined PBL, specific disciplines, or the specific scenario, though these were atypical.

8.4. Factors that enable or impair aspects of critical thinking.

The third research question asked what interactions exist between the different elements of the adapted CoI Framework, and what this says about enablers of, and impediments to critical thinking. Colour-coding of tabulated utterances assigned to cognitive, social or teaching presence allowed easy identification of single utterances coded to more than one element; or consecutive utterances coded to different elements: respectively, interaction of elements within or between utterances. Additionally, there was sometimes interaction between different categories within a single element.

8.4.1. Interaction between categories within a single element.

Sometimes, as described in 8.1, multiple aspects of critical thinking were identified within a single utterance, which was the closest an individual within the PBL CoI came to demonstrating critical thinking in its entirety. However, interaction between aspects

of critical thinking, or cognitive presence, was also reflected in consecutive utterances coded to this element. Thus discourse *per se* enabled sustained cognitive presence. This is consistent with Lipman's (1991) contention that 'discursive inquiry' (p.73) amongst members of a CoI facilitates cognitive presence.

A feature of several PBL discourses was interaction between positive and negative manifestations of teaching presence, sometimes in a single utterance, sometimes in consecutive utterances. For example, when a student facilitated understanding by identifying conflicting information (F3, Y1C3T1, U31), that same utterance represented a missed opportunity for the facilitator to enable critical thinking by encouraging students to come to a shared understanding of the topic. A more complex interaction between positive and negative teaching presence was where a Year 2 student facilitated her own understanding (F4, Y2B3T2, U27) of the biochemical function of γ-glutamyl transferase, by recounting what she knew about the enzyme and seeking support for this. The video-recording showed the Facilitator nodding whenever she was correct, which was interpreted as him facilitating development by giving feedback, but also as a missed opportunity to enable aspects of critical thinking, by encouraging other students to validate F4's understanding.

Finally, there were many instances of interaction between hard and soft scaffolding teaching presence: for example, where the structure provided by the PBL process (see 7.9.3) or the use of a resource (see 7.3.3) facilitated students moving through the process, or where a resource provided a means for facilitating understanding (see 7.2.3, Appendix K).

8.4.2. Interaction between elements of the adapted CoI Framework.

Given my aim to identify enablers of, and impediments to critical thinking, it was of especial interest to examine the interaction between elements of the adapted CoI Framework (Garrison *et al*, 2000), to identify factors impacting on critical thinking. Chapters 6 and 7 described many examples of interactions between pairs of elements,

especially between social and teaching presence; and between teaching and cognitive presence. Sometimes such interactions were seen within a single utterance, but often in consecutive utterances. The latter were more informative in answering research question three, since they permitted inferences about enablers of and impediments to aspects of critical thinking.

Also, there were instances of interaction between all three elements of the CoI Framework. One example was seen during brainstorming about the causative agent of pneumonia, by group Y1B3 (U161 to U174; see Appendix L), in which several manifestations of teaching presence - resource, facilitating understanding by identifying conflicting information and by probing, facilitating development by providing support - interacted with all five aspects of cognitive presence, which were contributed by different students; and also interacted with the cohesion category of social presence. With group Y2C3 (see 7.9.3), teaching presence manifest as facilitating development through encouraging reflection (U265) led directly to the resolution step of cognitive presence, as F2 reflected (U266) on her thoughts about the frequency of hepatitis amongst drug users; teaching presence simultaneously led to the emotional expression category of social presence, as the student referred to this knowledge as frightening.

8.4.3. The impact of social presence on aspects of critical thinking.

Much of the research on the CoI Framework has focussed on identifying indicators for one particular element: either cognitive presence (Garrison *et al*, 2001) or social presence (Swan, 2002, 2004) or teaching presence (Anderson *et al*, 2001). Others have been interested in how a specific element, generally social presence, changes over time (Swan, 2002, 2004; Swan & Shih, 2005). Only more recently have publications emerged where the focus has been on how one particular element may impact on another. However, this is potentially the most important area of inquiry, especially if one is interested in finding out how best to enable critical thinking by students. The remainder of this chapter looks at ways in which social and teaching presence impact on cognitive presence.

Analysis of interactions between cognitive and social presence provided little direct evidence that social presence enabled critical thinking, but there was generally evidence for a positive social environment and positive social interactions, which should be conducive to making hypotheses and suggestions, and attempting to validate one's thinking by sharing information or conclusions. The ability of discourse to facilitate cognitive presence (Lipman, 1991) was demonstrated (for example, see Appendix K). Social presence potentially enabled teaching presence, in that the positive atmosphere may have encouraged students to draw diagrams, or to facilitate their understanding by seeking support for their knowledge constructions; such hard and soft scaffolding teaching presence was in turn shown to enable aspects of critical thinking. We may therefore conclude that there are two potential mechanisms for social presence to enable aspects of critical thinking, indirectly.

Negative manifestations of social presence indirectly impaired aspects of critical thinking: examples were where the joking or the dynamic between CoI members brought to a halt discourse featuring aspects of critical thinking. Regarding the impact of social presence on critical thinking, then, there must be a sufficiently positive social environment to encourage discourse, to indirectly enable aspects of critical thinking; but where the social environment detracts from a cohesive approach to the inquiry, there will likely be a negative impact on critical thinking. This resonates with the distinction others have made between different forms of social presence: affective communication necessary to establish and maintain the social relationship between group members (Garrison, 2007) and communication that reflects a cohesive approach to the intellectual task (Swan & Shih, 2005). An important role of the chair and facilitator is to ensure these are present in their right proportion.

8.4.4. The impact of teaching presence on aspects of critical thinking: overview.

Interactions between teaching and cognitive presence were plentiful in all twelve discourses. It was clear that teaching presence directly enabled various aspects of critical thinking. This was true both for soft and hard scaffolding teaching presence. In terms of soft scaffolding, examples included where facilitation of understanding by asking a question (Fac, Y1C3T1, U15) or by identifying conflicting information (F1, Y1C3T1, U84) was directly followed by utterances coded to cognitive presence; see also Appendices K and L. In terms of hard scaffolding, diagrams on the whiteboard, an indicator of the resource category of teaching presence, directly facilitated the hypothesis formation and explanation indicators of internal exploration, as seen in a lengthy contribution explaining the action of memantine (M2, Y1B2T1, U203). The impact of soft and hard scaffolding teaching presence in enabling aspects of critical thinking is discussed further in sections 8.5 and 8.6, respectively.

Critical thinking could be prevented through inadequate soft scaffolding teaching presence, with facilitators missing opportunities to enable aspects of critical thinking; or through inappropriate use of hard scaffolding. For example, over-use of the dictionary (F3, Y1B2T2, U46) prevented aspects of critical thinking, since it undermined the brainstorm; it also impacted negatively on group cohesion, offering another mechanism for indirect negative impact of a resource on cognitive presence. Occasionally there was direct impairment of critical thinking through inappropriate expression of teaching presence, such as when the facilitator of Group Y2B3 (U87) interrupted F5's contribution, and brought her external exploration about bilirubin to a halt.

8.5. Types of soft scaffolding and their impact on critical thinking.

Facilitators' utterances were not coded to cognitive presence. The focus was on critical thinking by students, and facilitator interventions were of interest only inasmuch as they enabled or impaired critical thinking by the CoI. In contrast, students' utterances were coded to cognitive presence as appropriate; but students also contributed to soft

scaffolding teaching presence via their facilitative input. Different types of facilitative input were demonstrated by facilitators and students to greater or lesser degrees.

8.5.1. Facilitating understanding.

Questioning.

When a student asked a question, it was generally assumed they were not intending to be facilitative and the utterance was coded to the internal exploration aspect of critical thinking, as an example of seeking information, confirmation, or clarification. In some cases, where the student gave what seemed to be a personal construction of knowledge and asked if this was correct, this was coded as teaching presence, since it was considered that they were facilitating their own understanding. Very occasionally, it appeared from the context that a student was trying to facilitate his/her peers' understanding through questioning, and in such cases they were fulfilling the role of facilitator. Asking questions (Wilkie, 2000), or elicitation (Gilkison, 2003), is a recognised facilitation skill; and it was assumed that whenever facilitators in the present study asked a question, they knew the answer already, or were not necessarily interested in the answer for its own sake, but were questioning students to test or facilitate their understanding.

In her research on skills employed by facilitators in a pre-registration nursing diploma programme, Wilkie (2000) found questioning to be used most commonly. Consistent with this, questioning was a strategy employed by all facilitators in the present study, particularly in step 3 of the PBL process, brainstorming, and in step 6, sharing information from independent research. Closed questions, with limited options for response, were less successful at eliciting sustained cognitive presence than were open questions; for example, in discussing glucuronidation, when one facilitator asked 'what [chemical group] have we stuck on?' (Y2B3T1, U53), he received a three-word response, representing external exploration via information exchange. Facilitators who asked open questions prefaced with *why* and *how* tended to enable the internal exploration aspects

of critical thinking, since these questions encouraged hypothesis formation and the offering of tentative explanations. For example, regarding the relationship between flu and pneumonia, a facilitator asked: 'why do you think one might lead to the other?' (Y1B3T1, U288), which led to several hypotheses being offered. Similarly, in discussing the pathophysiology of stroke, a facilitator asked: 'why does a bleed damage the function of the surrounding cells?' (Y1B2T2, U398), which was followed by the creative thinking component of critical thinking: internal exploration and integration. *Why* and *how* questions would come within Wilkie's (2000) elaboration category, which she defined as questions that probed students' knowledge or prompted [higher-order] thought. Another category of question defined by Wilkie (2000) was one that verified completeness: where the facilitator hinted there was more information to be provided, or the matter was more complex than had been implied. Such questions could be directive, prompting or challenging, and Wilkie (2000) found that her participants were most likely to ask directive questions. In this study, examples were found for all three types of question. Thus, 'what about the role of interferon here?' (Fac, Y2C3T1, U159), directed Group Y2C3 to talk about this cytokine, enabling internal and external exploration**.** The prompting question, 'do you think the cough reflex is as strong in an older person?' (Fac, Y1A3T2, U279), encouraged Group Y1A3 to review the cough reflex; this intervention led to some internal exploration, and several instances of external exploration, via information exchange. The question, '[bile] salts and acids are the same thing?' (Fac, Y2C3T2, U117), challenged Group Y2C3 and directly enabled a series of utterances coded to the external exploration, internal exploration and resolution aspects of critical thinking. Clearly, different types of question are useful in enabling critical thinking, and different aspects of critical thinking.

Finally, the tone in which questions are asked could be important, since this may influence social presence, which could indirectly enable cognitive presence. In this regard, the facilitator of group Y2B3 at times seemed interrogative, rather than facilitative. Nevertheless, his interventions often enabled cognitive presence.

Probing.

Probing, one of the indicators for facilitating understanding, is similar to the facilitation skill of re-elicitation (Gilkison, 2003), which might involve repeating a question, rephrasing it, or otherwise indicating 'that the previous response … was inadequate' (*ibid*.). This was a strategy used by all but one facilitator (Y1C3) in step 6, where students brought to the CoI their personal knowledge constructions following independent research. It is unsurprising that probing would feature here. The facilitators of Y1B3 and Y2B3 also used probing in the brainstorming step. In a particularly notable example with Group Y1B3, the facilitator asked several probing questions (U552, U556, U558, U560, U563) to encourage students to take on board an objective about normal respiratory defences against pathogens. Finally, she was successful, when, 'If [the pathogen's] in the outside air how does it get from there to the lungs? What does it have to overcome to get there?' (U563) elicited 'Your barrier defences.' (F4, Y1B3T2, U564). Generally, probing enabled aspects of critical thinking, especially external exploration, internal exploration and integration.

Providing clarification.

Facilitating understanding by providing clarification on previous input was often a function of students. For example, in the brainstorm, M4 in Group Y1B2 clarified that stroke 'is reversible in the sense [that] you can gain your function back.' (U614). This enabled social presence, as F2 and F3 supported the idea, and cognitive presence, since F3 exchanged information that physical damage to brain tissue was not reversible (U615). However, providing clarification sometimes closed a line of discussion.

Identifying conflicting information.

Facilitators and students contributed this indicator of teaching presence, which generally enabled aspects of critical thinking. Thus, in a brainstorm about stroke, a student identified what seemed to him conflicting information, that having one stroke

predisposed the individual to a second. He said, ‘once you’ve had one surely you’re kind of monitored more’ (M3, Y1C3T2, U353). This was followed by several students offering hypotheses (U355, U358, U360), explanations (U361, U366, U369), integration (U356) and information (U359) to account for this apparent paradox. Thus teaching presence enabled the creative thinking component of critical thinking, plus external exploration.

8.5.2 Facilitating development.

Giving feedback.

Indicators for facilitating development included feedback to the individual and feedback to the group, which resonate with Gilkison’s (2003) facilitation skills of giving feedback and evaluating, since feedback is necessarily preceded by evaluation of performance. As discussed earlier (see 8.3.2), in this study mainly facilitators of Year 2 groups provided direct feedback. Feedback tended to enable the internal (F4, Y2B3T2, U348) and external exploration (F2, Y2B3T2, U350; F4, Y2C3T2, U344; M2, Y2C3T2, U459) aspects of critical thinking.

Providing support.

Gilkison’s (2003) identification of summarising as a facilitation skill chimes with facilitating development through providing support. Facilitator support for ideas was interpreted as facilitating development, because of the power relationship between student and facilitator; whereas support for ideas from peers was interpreted as a social function, aiding group cohesion. Summarising the discussion provides support since it gives indirect feedback that appropriate, relevant information has been shared. An example is where a facilitator summarised (Y2B3T1, U204) the CoI discourse about ways in which a viral infection might be diagnosed. Another technique, used by the facilitators of Y1C3 and Y2C3, was to provide support via anecdotes relating to student contributions, implying agreement with their ideas, or providing additional details.

Facilitating development through providing support directly enabled aspects of critical thinking. For example, in discourse Y2C3T2, it enabled external exploration (F1, U276; F1, U436; M2, U438; F4, U503), internal exploration (M3, U264; F1, U276; M2, U280; F2, U428; M2, U438; F1, U498; F4, U503) and integration (F1, U430; F2, U595).

Role-modeling.

Another aspect of facilitating development is modeling behaviours appropriate to participating in a CoI, which would include questioning (see 8.5.1). When the facilitator of Y2C3 modeled arriving at a new understanding about ultrasound treatment for kidney stones, this directly enabled external exploration (F1, U464) and integration (M3, U469). Facilitators also modeled active listening, which, if adopted by the CoI, would serve as a mechanism for fostering group cohesion - an example of teaching presence enabling social presence, which could then indirectly enable cognitive presence.

Encouraging meta-cognition and self-directed learning.

Facilitators also have a role in fostering self-directed learning (SDL) capability (Katz, 1995). By Schmidt's (2000) definition, this is about students defining the learning activities or focus. Consistent with this, one facilitator noted, 'It's not my job to chip in' (Y1B3T2, U329). Garrison (1997) defined SDL as including motivation, self-management and self-monitoring (see 2.3). This last aspect is related to appraising cognition and meta-cognition, consistent with the resolution aspect of critical thinking. However, there was relatively little evidence for facilitators explicitly encouraging meta-cognition or reflection on learning; one example was in Y2C3T1, (U265).

8.5.3 Facilitating process.

Generally, this aspect of teaching presence was contributed by the student chairs, although other students and facilitators also contributed. Chairs generally made collaborative comments, encouraging joint ownership of the process and a cohesive approach to the inquiry. The chair in the occasionally dysfunctional group Y1B2 tried

using the **s**tructure of the PBL process and her personal facilitation skills to tackle negative manifestations of social presence (F2, Y1B2T2, U160, 307, 555), with limited success. As discussed in 8.4.3, an appropriate balance between positive and negative aspects of social presence is likely essential for ensuring a cohesive approach to the intellectual task (Swan & Shih, 2005), and hence for enabling cognitive presence. Promoting students' awareness of good group dynamics and developing their chairing skills could ultimately impact on critical thinking within the PBL tutorial.

Successful methods for facilitating process included summarising (Gilkison, 2003), which can bring a line of discussion to a close. The facilitation skill of refocusing (Gilkison, 2003) is employed when there is a digression from the main topic, or where students are dwelling on a minor point. An example of refocusing was the facilitator in Group Y1B3 saying, 'don't go too much down this road' (U281), to prevent students focusing on a flu/pneumonia link.

Thus social presence, hard scaffolding afforded by the PBL process, and soft scaffolding teaching presence may all be brought to bear in facilitating the process. This in turn may indirectly enable cognitive presence, by giving more time for productive discourse.

8.5.4 Directive input.

Gilkison (2003) identified informing as a facilitation skill where information is provided without any expectation of a response from students. Although this is discouraged in the featured curriculum, Appendix J makes clear that several facilitators did impart didactic information. This did not generally enable cognitive presence. Gilkison's (2003) facilitation skill of directing learning is similar to directive input via giving advice, which could enable cognitive presence. For example, the utterance, 'You've only really looked at one risk factor. So you maybe want to do that.' (Y1B3T2, U223) was followed by a run of internal exploration.

8.6 Types of hard scaffolding and their impact on critical thinking

Hard scaffolding was defined in 3.3.8 as related to the design or resourcing of the learning opportunity, via materials prepared or provided by faculty to stimulate and support learning. In the adapted CoI Framework, there were two categories of hard scaffolding: structure and resource.

8.6.1 Structure

The structure afforded by the PBL process generally enabled soft scaffolding teaching presence, in the form of facilitating the process. As suggested in 8.5.3, this could in turn enable cognitive presence. A variation was Group Y1C3's numbering of learning issues in step 2, which led directly to the internal exploration, external exploration and integration aspects of critical thinking (U79 to U105), as students prioritised discussion topics and gave their justifications. This is reminiscent of the ordering of questions by primary schoolchildren in Philosophy for Children classes (Lipman, 1995; see 3.3.9).

8.6.2 Resources

In this study, the major hard scaffolding resource was the scenario, whose function was to provide a stimulus for learning. Scenarios need to arouse interest and delineate the inquiry sufficiently to make it manageable (Simon & Ertmer, 2005). In medical education, we expect interest to be aroused by: (i) ill-structured, patient-centred scenarios that mimic the clinical context, as with all six scenarios in this study; (ii) scenarios whose characters are related to those from previous scenarios, such as one explored by groups Y1C3 and Y1B2, featuring Bruce, the businessman who had had a stroke, and whose mother had featured in a previous scenario about dementia; or (iii) scenarios whose topics allow for integration with experiences from other parts of the course and/or students' personal experience, such as the social medicine scenario on care of the elderly, explored by Y1C3 and Y1B2. In all cases, the scenarios in this study enabled identification of learning issues; hence hard scaffolding teaching presence

directly enabled the trigger aspect of critical thinking. In addition, application of information or concepts (F1, Y1C3T2, U526) to the PBL scenario demonstrated that hard scaffolding can directly enable the resolution aspect of critical thinking, and this is something the facilitator could encourage.

Scenarios could also enable soft scaffolding teaching presence. For example, in group Y1B3, when M4 said 'the history taken seems fairly limited so far' (U342), the Facilitator responded with, 'That's to prompt you to look at the history…if he told you the history then there would be no question there.' (U343). Thus the scenario enabled the facilitator to encourage reflection on learning, thereby facilitating development.

The whiteboard was another hard scaffolding resource that enabled soft scaffolding, via facilitating understanding. This was seen in scenarios that required students to grapple with pharmacological mechanisms, pathophysiology or metabolic processes. Although a blood film was provided in the malaria scenario, it was not much-used; possibly because it was really intended for the brainstorming step for that scenario, which happened prior to the filmed tutorial. The final resource available in the featured scenarios was the dictionary. Not surprisingly, this was well-used in step 1, definitions. However, as discussed earlier (see 7.2.2. and 8.4.4), inappropriate use of the dictionary potentially had a negative impact on cohesion and may have impaired critical thinking indirectly, by reducing the possibilities for brainstorming.

To summarise this Chapter, hard and soft scaffolding can directly enable aspects of critical thinking, and this is especially true for questioning, probing and providing developmental support. Sometimes hard scaffolding enables aspects of critical thinking indirectly, by first promoting soft scaffolding teaching presence.

Chapter 9. Discussion.

This chapter picks up themes from the critical literature review and methodology chapters, and considers them from the retrospective vantage point of having applied a socio-constructivist Community of Inquiry (CoI) framework to study critical thinking in the context of PBL tutorials in the early years of a Scottish medical curriculum.

9.1. Reflection on relevance of different conceptualisations of critical thinking to the PBL context.

9.1.1. Critical thinking as a series of aligned cognitive activities.

At the outset of this study, my conceptualisation of critical thinking was as a series of aligned cognitive activities, including questioning, reasoning, evaluating statements, forming judgments, and meta-cognitive activity (see 3.3.1). Preliminary analysis of PBL-derived data confirmed this conceptualisation was not especially useful in identifying critical thinking within PBL tutorials in the featured curriculum. Application of the adapted CoI Framework (see 3.4) confirmed that questioning was relevant, but it was more complex than imagined from viewing critical thinking as aligned cognitive activities, since some questions were direct indicators of the external exploration aspect of critical thinking; whilst others were examples of teaching presence (see 8.5.1) that could enable aspects of critical thinking.

There was little evidence in the present study for explicit reasoning in the sense of formal or informal logic. However, the hypothesis and explanation indicators for internal exploration equated to possible and probable reasons to account for specific observations. They were similar to instances of reasoning identified by Da Silva and Dennick (2010), on the basis of indicators such as *if* and *because*. Sometimes PBL CoI members evaluated statements; this was seldom explicit, but was implied whenever they identified conflict. Some utterances coded to the resolution aspect of critical thinking

were judgments or reflections on thinking, but these were relatively uncommon. The PBL process notwithstanding, the relatively unstructured nature of the PBL discourse does not readily lend itself to sustained, explicit reasoning, evaluating and judging, making the aligned cognitive activities conceptualisation of limited usefulness. Add to this its failure to take into account the social context of the PBL tutorial, and the fact that it does not permit identification of enablers of, and impediments to critical thinking, and it is clear this conceptualisation is not appropriate to study critical thinking in the context of a PBL tutorial.

9.1.2. Critical thinking as alternating phases of creative thinking and validation/verification.

Conceptualisations of critical thinking that incorporate a creative thinking component (Brookfield, 1987; Garrison, 1991, 1992; Garrison *et al*, 2000) are particularly relevant to the PBL context, at least as practised in the featured curriculum. Creative thinking relates to activities occurring in the internal world (Garrison, 1992), the mind of the individual member of the CoI, although such thinking is implied by subsequent contributions to the external world (*ibid*.) of PBL discourse. In the adapted CoI Framework, creative thinking equated to the internal exploration and integration categories of cognitive presence (Table 3.5), and analysis of all twelve discourses in this study revealed abundant evidence for creative thinking, with various indicators for each of the relevant categories (Appendix J).

It is also appropriate to this study to view critical thinking as cycling between two phases (Brookfield, 1987; Garrison, 1991, 1992) of imagining alternatives/creative thinking and identifying assumptions/validation, since the validation aspect takes account of the social context of the PBL tutorial. Moreover, there was evidence for the creative thinking and validation phases in the discourses analysed. However, if one superimposes the five stages of critical/reflective thinking (Dewey, 1933; Garrison, 1991), as in the adapted CoI Framework (see 3.4), the trigger, external exploration and

resolution stages/categories equate to the identifying assumptions/validation phase (Table 3.5); it then becomes clear there is limited manifestation of the validation phase in the PBL context, in that there were fewer indicators for, and less use of, the trigger and resolution categories by students in a PBL CoI.

Regarding the minimal evidence for the trigger category, this likely reflects the structure of PBL tutorials, in which the problem is defined by faculty via the scenario presented to students, and the PBL process allots limited time to the identification of the problem - namely, identifying issues in step 2. In content analysis of asynchronous online discussion, Garrison *et al* (2001) coded only 8% of postings to the trigger category and noted the problem or issue was well-framed by the teacher. The relative lack of resolution in the PBL context is also consistent with the findings of Garrison *et al* (2001), who coded 4% of postings as resolution. They offered several explanations: the goal or content of the online lesson did not allow for the type of 'advanced inquiry' (*ibid*., p.20) that would require reflective thinking; there may have been deficiencies in facilitation; computer-mediated communication (CMC) may not be a context that supports reflective activity, though this seems unlikely; or the CoI Framework may not have been relevant to CMC. A relative lack of resolution in the PBL context would not likely be due to the content of the scenarios, since all of them potentially afforded opportunities for application of and reflection on the consequences of knowledge. It is possible that specific facilitative interventions are needed to enable resolution. Moreover, the rapid verbal exchanges in the PBL context may not allow time for reflection on the consequences of new knowledge, for application of that knowledge, or for reflection on learning or thinking. Also, the positive social environment, whilst indirectly enabling some aspects of critical thinking, may contribute an informality and sufficient lack of structure as to make reflection unlikely. So lack of resolution may be a consequence of the PBL learning context, and resolution may require specific scaffolding activities (see 9.2).

9.1.3. Critical thinking as hierarchical stages.

If one views critical thinking as cycling between phases of imagining alternatives/creative thinking and identifying assumptions/validation of that thinking (Brookfield, 1987; Garrison, 1991, 1992), there is no need to suppose that either phase is more important than the other. However, where critical thinking is conceptualised as four (Garrison *et al*, 2000) or five (Dewey, 1933; Garrison, 1991) stages, there may be an assumption that thinkers progress through the stages not just in a temporal manner (see 8.1.1), but in a hierarchical manner. Whilst Garrison (1991) argued that critical thinking may not necessarily proceed in the linear fashion implied by his five-stage model, and that it may not be easy to recognise the various stages, Garrison *et al* (2000, 2001) took a hierarchical perspective towards the categories in the cognitive presence component of their CoI Framework. Garrison *et al* (2001) found in online situations that students often failed to demonstrate the integration or resolution stages of cognitive presence. These authors clearly viewed resolution as the pinnacle of critical thinking. However, this can be contested: without the 'lower' (*ibid*.) categories that reflect creative thinking, namely internal exploration and integration, the thinker may be limited to critiquing the existing situation, but unable to imagine alternatives (Brookfield, 1987): they may in effect be weak-sense critical thinkers (Paul, 1995).

In spite of rationalising at the outset that no one stage of critical thinking is necessarily more important, when analysing the data in Chapters 6 and 7, I did tend to slip into mimicking the stance of Garrison *et al* (2001). On reflection, internal exploration, integration and resolution would require the sort of active processing that, in Dewey's (1933) terminology, distinguishes genuine reflective/critical thinking from belief. Because the problem is set by faculty, problem identification, the trigger, may require relatively little intellectual input from students; and whilst external exploration may reflect knowledge construction outwith the PBL tutorial, within the PBL context it appears simply to be articulation of unexamined prejudices, to paraphrase Dewey (1933). Yet the information-gathering demonstrated in external exploration may well

facilitate other aspects of critical thinking by the PBL CoI, so in this sense external exploration remains important. In conclusion, all five stages of critical thinking (Dewey, 1933, Garrison, 1991; also 3.4) contribute an important aspect of the whole, but because internal exploration, integration and resolution evidence indicate 'conscious processing of experience' (Lipman, 1989, p.5) during the PBL tutorial, they arguably merit higher regard in this context.

If one adopts a hierarchical perspective of the stages/aspects of critical thinking, there is a risk that utterances may be inappropriately coded to a higher stage. For example, it was previously discussed (6.2.3) whether a teasing remark (F3, Y1C3T2, U639) represented the resolution aspect of critical thinking, indicated by reflection on learning, since it may have signified an appreciation that discourse via PBL can lead to better understanding of a topic. However, the student may simply have been churning out local dogma: that lectures equate to being taught, whereas PBL equates to learning. There is perhaps a temptation to elevate students' utterances, or to mistakenly credit students with intention to think critically. Garrison *et al* (2001) instructed raters to code down to what they described as a lower category of cognitive presence if it was unclear which of two categories was appropriate; where a posting clearly related to at least two categories of cognitive presence, raters were to code up to what was described as the higher category. Thus Garrison *et al* (2001) sought to code to a particular stage of critical thinking only if they had confidence in the evidence. In the present study, there was no intention to view the categories of cognitive presence as hierarchical. Instead, utterances were coded according to the closest match to descriptors (Appendix F); where there was uncertainty, the development of additional indicators helped clarify to which category an utterance belonged. Where an utterance genuinely related to more than one category of cognitive presence, this was described as interaction within the cognitive presence element of critical thinking (see 8.4.1).

9.1.4. Caring thinking as a component of critical thinking.

Lipman (1988, 1998) referred to critical thinking as higher-order thinking, and he perceived this as comprising critical thinking, equivalent to the validation phase in Garrison's (1991, 1992) writing; creative thinking; and caring thinking (Lipman, 1995). This latter construct involves thinking about values that are held, or ought to be held, by thinkers, and though not explicitly contained in Garrison *et al's* (2000) CoI Framework, or my adaptation, it could theoretically be demonstrated in the internal exploration aspect of critical thinking, if students offered alternative perspectives; or it could be demonstrated in the resolution aspect of critical thinking, if students applied their new knowledge or reflected on its consequences. PBL scenarios featuring psychosocial problems may facilitate discussion of personal or social values, since in a social group such as the PBL CoI, members are likely to bring different experiences or perspectives to bear. This may allow the CoI to engage in multi-logical, strong-sense critical thinking (Paul, 1995). Certainly, in the groups discussing care of the elderly, different values were aired. Lipman's (1995) incorporation of caring thinking is therefore relevant in the PBL context, at least where psychosocial scenarios are used.

9.1.5. Socio-constructivist conceptualisations of critical thinking.

Critical thinking in its entirety cannot be practiced by an individual in isolation, because it necessarily involves interaction with the external world (Garrison, 1992), whether in the form of peers in a social group such as a P4C classroom (Lipman, 1998) or a PBL CoI; or with the written, visual or oral records produced by the external world. Even the apparently independent critical thinker bases his thinking on problems identified in the external world and must present his thinking to the external world for validation. In a group situation, the need for a socio-constructivist perspective becomes even more apparent. Discourse was demonstrated to enable aspects of critical thinking in this study and examples were discussed earlier (see 8.4.1).

9.2. Utility of the adapted Community of Inquiry (CoI) Framework.

Garrison *et al* (2000, 2001) used their original socio-constructivist CoI Framework to perform content analysis of transcripts from asynchronous online tutorials. They reported difficulties in making coding decisions (Garrison *et al*, 2001), and that three training sessions were required for three raters to achieve an inter-rater Cohen's kappa reliability coefficient of 0.74 (*ibid*.), where 0.8 is desirable. A large proportion, 33%, of postings in the online sessions were not coded to any category of cognitive presence (Garrison *et al*, 2001), but the authors did not address whether they were indicators of social presence, teaching presence, or simply text that did not fit with any element of the CoI Framework. In contrast, virtually all utterances in the adapted CoI Framework could be allocated to cognitive, social or teaching presence, which suggests the adapted Framework is very relevant to the PBL context. The research described in this thesis was not content analysis, but interpretivist contextual analysis, akin to empirical discourse analysis; inter-rater reliability was not tested, since this seemed incongruent with the methodological approach, but the rationale for coding decisions was made explicit and the inclusion of descriptors for codes (Appendix F) makes it possible for the adapted framework to be used by others.

In their study of critical thinking in a PBL context, Da Silva and Dennick (2010) acknowledged that whilst they could detect indicators associated with reasoning, corpus analysis does not lend itself to determining whether that reasoning is correct. In contrast, this is possible with the type of interpretivist, contextual analysis described in the present study. However, whilst the descriptors for indicators of cognitive presence are generic and could be applied in any discipline, coders will likely require subject-specific knowledge to apply the adapted CoI Framework to discourses in their particular discipline. Without knowledge of the topics discussed in the discourses featured in this thesis, it would have been difficult to assign certain utterances.

With the adapted CoI Framework, it was possible to identify interaction between elements and thereby address research questions about enablers of, and impediments to, critical thinking. This gives the adapted CoI Framework a practical value in determining how teaching may be designed to enable critical thinking, which is addressed in 10.2.

Finally, Chapter 5 described coding dilemmas and how these were resolved: one novel use for the CoI Framework could be in staff development for facilitators. Applying the framework to an excerpt from a transcribed PBL discourse could help them to reflect on how best to enable critical thinking in PBL tutorials.

9.3. The role of social presence in the PBL CoI.

One strong indicator of social presence in the discourses in this study was the pervasive presence of emotional expression, manifest as humour. This was consistent with a perception of PBL as fun and hence motivational (Wood, 2003). However, there is an intellectual purpose to the PBL tutorial: inquiry, leading to learning. Garrison (2007) noted that research into social presence has often been conducted independently of cognitive and teaching presence, but in a CoI, the concern should be with how social presence contributes to successful inquiry and learning (Rourke & Kanuka, 2009). By interpreting interactions of all three elements of the adapted CoI Framework, the present study addresses this concern.

From this study, negative manifestations of social presence do not necessarily impede critical thinking. It may be that as long as the balance is towards a positive social environment, and positive social interactions, then critical thinking is not impaired; or it may be that social presence is not relevant for critical thinking to take place. However, it seems intuitive that students would be unlikely to contribute aspects of critical thinking if they expected to be judged harshly, and the corollary is that a supportive, safe learning environment should encourage aspects of critical thinking.

9.4. Teaching presence in the PBL CoI.

9.4.1. Soft scaffolding teaching presence: the role of the facilitator.

One of the first tasks of a facilitator on meeting a new PBL group is probably to establish a safe environment. In the face-to-face context, social relationships can form quickly, and non-verbal communication is possible (Garrison, 2007), so the facilitator may not need to do much to enable social presence, at least of the affective variety (Swan & Shih, 2005). On the other hand, the facilitator's physical presence could intimidate and inhibit discourse, so it is probably important for facilitators to project a relaxed, friendly manner. Facilitators in this study apparently made use of humour (Y1C3, Y1B3) or anecdotes (Y1C3, Y2C3) to create a safe environment.

The facilitator in a face-to-face PBL context has little opportunity to reflect, so s/he needs to be opportunistic in identifying when to intervene and enable aspects of critical thinking. In this study, cognitive presence was identifiable regardless of whether the facilitator intervened frequently (Y2B3) or infrequently (Y1A3). With the facilitator of Y2B3, his contributions amounted to about 25% of the discourse, but there was no evidence that this enabled more members of that CoI to engage with multiple aspects of critical thinking, or to demonstrate a wider variety of indicators for the different categories. This degree of facilitator intervention quite possibly impacted negatively on the students' opportunities to think critically, since they had substantially reduced time for discourse. As with social presence, it may be a matter of contributing sufficient and appropriate teaching presence to enable critical thinking. Alternatively, since aspects of critical thinking were identified regardless of how much the facilitator intervened, one could argue it almost makes no difference what the facilitator is like: critical thinking will occur anyway. Nevertheless, the analyses in Chapters 6 and 7 showed that specific facilitative interventions can change the quality of the discourse, often by stimulating students to engage with the creative component of critical thinking. So the challenge for facilitators is to intervene in ways to enable different aspects of critical thinking.

There is abundant evidence from the discourses analysed that aspects of critical thinking are directly enabled by interventions that facilitate understanding, such as questioning, probing, and identifying conflicting information. This is consistent with previous literature on good facilitation skills (Gilkison, 2003; Wilkie, 2000). Whilst interventions that facilitate development and process may well enhance students' capacity for self-directed learning (Schmidt, 2000), or at least self-regulated learning (Garrison, 1997), as a rule they did not directly enable aspects of critical thinking in the context of the PBL tutorial.

In all discourses in this study, there were utterances coded as missed opportunities to enable critical thinking. One difficulty for any PBL facilitator is that s/he is trying to facilitate many different aspects of the PBL tutorial, including the students' deep understanding of the learning material, the PBL process, the group dynamic, students' transferable skills in verbal communication and collaborative working, and the learning environment (Katz, 1995). As aforesaid, facilitation is to some extent opportunistic: it is necessary to work with what arises during the PBL discourse, and within a limited time frame, so it is inevitable there will be missed opportunities to enable critical thinking.

9.4.2. The role of hard scaffolding.

Specific forms of hard scaffolding have particular impacts on critical thinking. For example, scenarios with a (patho-)physiological emphasis lend themselves to students using the whiteboard to draw diagrams and explain processes, which directly enables the creative thinking components of critical thinking, internal exploration and integration, as well as the information exchange indicator of external exploration. On the other hand, scenarios with a sociological aspect lend themselves to consideration of personal or societal values and potentially offer good opportunities for students to apply their ideas, or to reflect on consequences of these. Sociological scenarios allow students to engage in multi-logical, strong-sense critical thinking (Paul, 1995), and to practice caring thinking (Lipman, 1995).

9.5. Developing and assessing critical thinking in PBL-containing medical curricula.

In this study, based on the aspects of critical thinking demonstrated in various steps of the PBL process, evident in the pattern of indicators (Appendix J), there was no particular evidence for differences in critical thinking by students in Years 1 or 2 of the featured curriculum. So whilst critical thinking by the CoI clearly took place during PBL tutorials, this study did not provide evidence that PBL actively promotes critical thinking ability (Maudsley & Strivens, 2000a, 2000b), in the sense that students developed that ability over time. To find such differences using the adapted CoI Framework, one approach would have been to view the categories of cognitive presence as hierarchical and to look for a greater frequency of higher stages of critical thinking with increasing exposure to PBL. However, this would have been inconsistent with an interpretivist approach. An alternative might be to look for qualitative differences over time, in the variety of aspects of critical thinking, and the variety of indicators for each aspect, contributed by students with varying exposure to PBL. It would be appropriate to follow the progression of a single PBL group in successive PBL tutorials, possibly with the facilitator primed to make interventions designed to encourage different aspects of critical thinking: for example, to encourage resolution, explicitly asking students to apply their ideas to the specific scenario. This theme is returned to in 10.2

9.6. The study design

9.6.1: Positive aspects

Adaptation of Garrison *et al*'s (2000) CoI Framework allowed me to apply a socio-constructivist perspective to critical thinking in the social context of a PBL tutorial, yet utilise more relevant categories for teaching presence, since the role of the PBL facilitator was likely to be different to that of the online tutor. The deliberate study of all three elements in this adapted CoI Framework allowed me not only to look for critical

thinking, but to make conclusions about enablers of, and impediments to aspects of critical thinking.

The fact that groups addressed a variety of clinical scenarios allowed me to identify that critical thinking was not dependent on a specific topic or style of PBL scenario, and I appreciated the value of scenarios that featured sociological, pathophysiological or pharmacological problems. Similarly, the serendipitous study of facilitators with a variety of styles allowed me to appreciate the value of different types of intervention and that quality is probably more important than quantity.

Audio-recordings were useful for identifying tone, which, for example, let me appreciate the shock felt by the student chair of Y1C3, when his peer talked about his father having had a stroke. However, video-recordings proved invaluable for identifying speakers, for noting some non-verbal communication, and for noting when something untoward occurred; such as the fact that the facilitator of Y1C3 left the room for a while.

Rich descriptions of coding dilemmas, and discussing these with my supervisors, allowed me to build confidence in my use of the adapted CoI Framework as a coding scheme and to draw up descriptors for each code (Appendix F). Preparation of duplicate tables of data and justifications of coding decisions (Appendix G) helped me to interpret the data; as did other manipulations, such as tabulating the indicators identified in each discourse (Appendix J), and the contributions by individual students or facilitators (data not shown).

9.6.2. Limitations

Typically with qualitative research, one criticism that may be leveled is its lack of generalisability (see 5.1); however, a more appropriate concept is transferability: that is, whether the findings will be meaningful in other contexts and will resonate with findings by other researchers. There is reason to think this is so, especially given similarities in my findings and those of Garrison *et al* (2001) and Basu Roy and

McMahon (2012), who both found a preponderance of utterances coded to categories equivalent to my external and internal exploration.

The data were predominantly coded by one individual. However, as described above, coding dilemmas were discussed; and coding decisions for the first three transcripts were explicitly justified. It was not appropriate to measure inter-rater reliability, because there was no intent to perform content analysis; rather, the method was interpretivist, contextual analysis. Findings were not member-checked by participants. These latter were no longer readily accessible, being students who had moved on from the pre-clinical years. However, there is arguably no need to member-check if one is undertaking interpretivist research (Sandelowski, 1993, 2002), and mechanisms such as thick and rick descriptions maximise the possibility of transferability (Carlson, 2010).

The limitations notwithstanding, this empirical research allowed me to draw several conclusions, which are described in the following chapter.

Chapter 10. Conclusions and significance for the profession.

10.1. Conclusions.

This study demonstrated that a socio-constructivist, Community of Inquiry (CoI) Framework is useful for conceptualising critical thinking as it occurs in the context of PBL tutorials, at least in the early years of a Scottish medical curriculum; and also for identifying factors that enable or impair critical thinking. Applying an adapted CoI Framework to twelve PBL discourses allowed the following conclusions to be drawn about critical thinking in this PBL context:

1. Critical thinking as viewed from a socio-constructivist perspective is a common feature of PBL discourses in the featured curriculum.
2. Aspects of critical thinking were identified in each of the discourses, for each group in this study.
3. Individual utterances were generally coded to just a single category of cognitive presence; thus students typically indulged in an aspect of critical thinking within a single utterance and did not sustain the whole cycle of creative thinking and validation/verification of that thinking.
4. Critical thinking in its entirety, whether envisaged as a cycle of creative thinking-verification, or as five stages of critical/reflective thinking, was a function of the CoI; that is, the PBL group.
5. Although some individual utterances contained as many as three or four aspects of critical thinking, this was the exception.
6. There was no sense of individual students or the CoI as a whole progressing sequentially through the five stages of critical/reflective thinking.
7. There was no particular evidence for differences in the critical thinking by PBL CoIs in Years 1 or 2 of the featured curriculum.
8. Individual students within each CoI in either year group were more or less likely to demonstrate critical thinking, as evidenced by the range of categories to which

they contributed and the variety or nature of indicators they contributed to any one aspect of critical thinking.

9. There was no direct evidence that social presence enabled critical thinking, but it may be assumed that the generally positive social environment and positive social interactions in the PBL CoIs in this study enabled discourse, which in turn directly facilitated aspects of critical thinking.
10. Social presence may enable cognitive presence indirectly, by one of two mechanisms: by providing a social environment conducive to discourse which can itself enable cognitive presence; and by enabling teaching presence which can in turn enable cognitive presence.
11. Negative manifestations of social presence did not seem to impair cognitive presence to any great extent, and it was concluded that if the social environment is, on balance, positive, then this may provide a sufficiently supportive environment to allow students to take a cohesive approach to the intellectual challenge of the inquiry.
12. It was clear that teaching presence directly enabled various aspects of critical thinking. This was true both for soft and hard scaffolding teaching presence.
13. Critical thinking could be indirectly impaired through inadequate soft scaffolding teaching presence, with facilitators missing opportunities to enable aspects of critical thinking; or through inappropriate use of hard scaffolding.
14. Occasionally, there was direct impairment of critical thinking through inappropriate expression of teaching presence.
15. Most of the variation in PBL discourses in this study reflected the way in which teaching presence manifest, particularly in terms of soft scaffolding: that is, the style of and interventions by the facilitator, and the degree to which the chair and other students were facilitative.
16. Teaching presence also varied in terms of hard scaffolding, particularly in relation to scenario content and the way in which this dictated the use or relevance of other resources.

To summarise, this study is unique in applying a socio-constructivist perspective of critical thinking to the PBL component of a Scottish medical curriculum. It provides evidence for aspects of critical thinking in PBL discourses: especially external exploration, the information gathering aspect; and also the creative thinking aspects, internal exploration and integration. These particular aspects are enabled by hard scaffolding in the form of a facility to draw diagrams, and soft scaffolding in the form of questioning, probing and identifying conflicting information; and this soft scaffolding may be provided by the facilitator or by students. On the other hand, the trigger and resolution aspects are potentially enabled by reference to the scenario.

10.2. The significance for the profession.

The critical literature review revealed that medical educators are seldom explicit in their definitions or conceptualisation of critical thinking; and in spite of claims that medical curricula promote critical thinking, evidence is thin on the ground. In particular, perception studies notwithstanding, there is still relatively little evidence to support claims that the PBL component of a medical curriculum develops students' critical thinking ability. The best evidence prior to this study included corpus linguistic analysis of PBL discourses (Da Silva & Dennick, 2010); or content analysis of the same (Basu Roy & McMahon, 2012; Kamin *et al*, 2001, 2003). As has been discussed, these studies had some limitations; in particular, they did not account for the social context of the PBL tutorial.

The doctoral research described in this thesis required the development of a relevant conceptual framework, and after critiquing various possibilities, I developed an adaptation of Garrison *et al*'s (2000) socio-constructivist CoI Framework, which proved particularly useful in studying critical thinking in the PBL context. This Framework potentially represents a radical way for medical educators to perceive critical thinking; it may be challenging for the medical education community to move away from what seems to be the favoured, if seldom articulated, perspective of critical thinking as a set of aligned cognitive activities. However, the adapted CoI Framework offers the

possibility to study critical thinking in other social contexts in medical education and training: for example, critical thinking by medical students in other small group formats; critical thinking by professional doctors during case conferences; or critical thinking by participants during interprofessional training sessions. The adapted CoI Framework is also a valuable addition to the methodological toolkit of the medical education researcher, offering the possibility not just to evidence critical thinking in social contexts, but to identify enablers and impediments. As discussed earlier, the Framework may be useful in staff development, to encourage facilitators to identify for themselves behaviours that enable or impair aspects of critical thinking.

The empirical findings from this study provide pointers as to how we may foster critical thinking by medical students during the PBL component of medical curricula. Facilitators should be encouraged to intervene in ways likely to enable critical thinking: by asking questions (Gilkison, 2003; Wilkie, 2000) that require students to indulge in hypothesis formation and explanations of (patho-)physiological mechanisms, which demonstrate the creative thinking aspects of critical thinking; by probing (*ibid*.) to elicit explanations of and justifications for statements; by identifying conflicting information, and encouraging students to propose how resolution could be achieved; by encouraging students to offer alternative perspectives on sociological issues (Paul, 1995); by asking explicitly that students apply their thinking in the context of the scenario or extrapolate to the wider society; by asking explicitly that students reflect on the consequences of their ideas for the fictitious patients in the scenario, or for medicine or society as a whole; and by encouraging students to reflect on their meta-cognitive knowledge and experiences, and measures they propose or take to monitor these (Garrison, 1997).

Facilitators must also attend to the social presence element of the PBL CoI in order to encourage discourse and a cohesive approach to the inquiry, personally contributing to social presence via their manner or, if this is their style, by specific contributions to humour; but they must ensure that the balance is maintained in favour of enabling critical thinking. The Facilitator should also encourage appropriate use of hard scaffolding, including adherence to the PBL process, and utilisation of resources in a

way that enables critical thinking. In particular, they should encourage use of the whiteboard; and they should encourage students to refer back to the scenario, to apply their thinking in that particular clinical context.

The use of varied scenarios, some directed towards learning of (patho-)physiological processes, others directed towards sociological concepts or problems, may enable different aspects of critical thinking during a teaching block.

Finally, students should be made aware of the role that PBL discourse can play in enabling their critical thinking ability; and how to make their personal contribution, both as a critical thinker and as an enabler of this in others. The importance of discourse, and of soft scaffolding facilitation skills, should be addressed in student induction to PBL, and in course documentation, with particular emphasis on the role of the chair and others in maintaining a positive social environment and a cohesive approach to the inquiry; and on the type of facilitative interventions the students themselves may make to enable critical thinking by other members of their CoI. If we can encourage this in our students, we will help to develop them not only as critical thinkers, but as truly self-directed learners (Garrison, 1997; Schmidt, 2000) and critical clinical practitioners.

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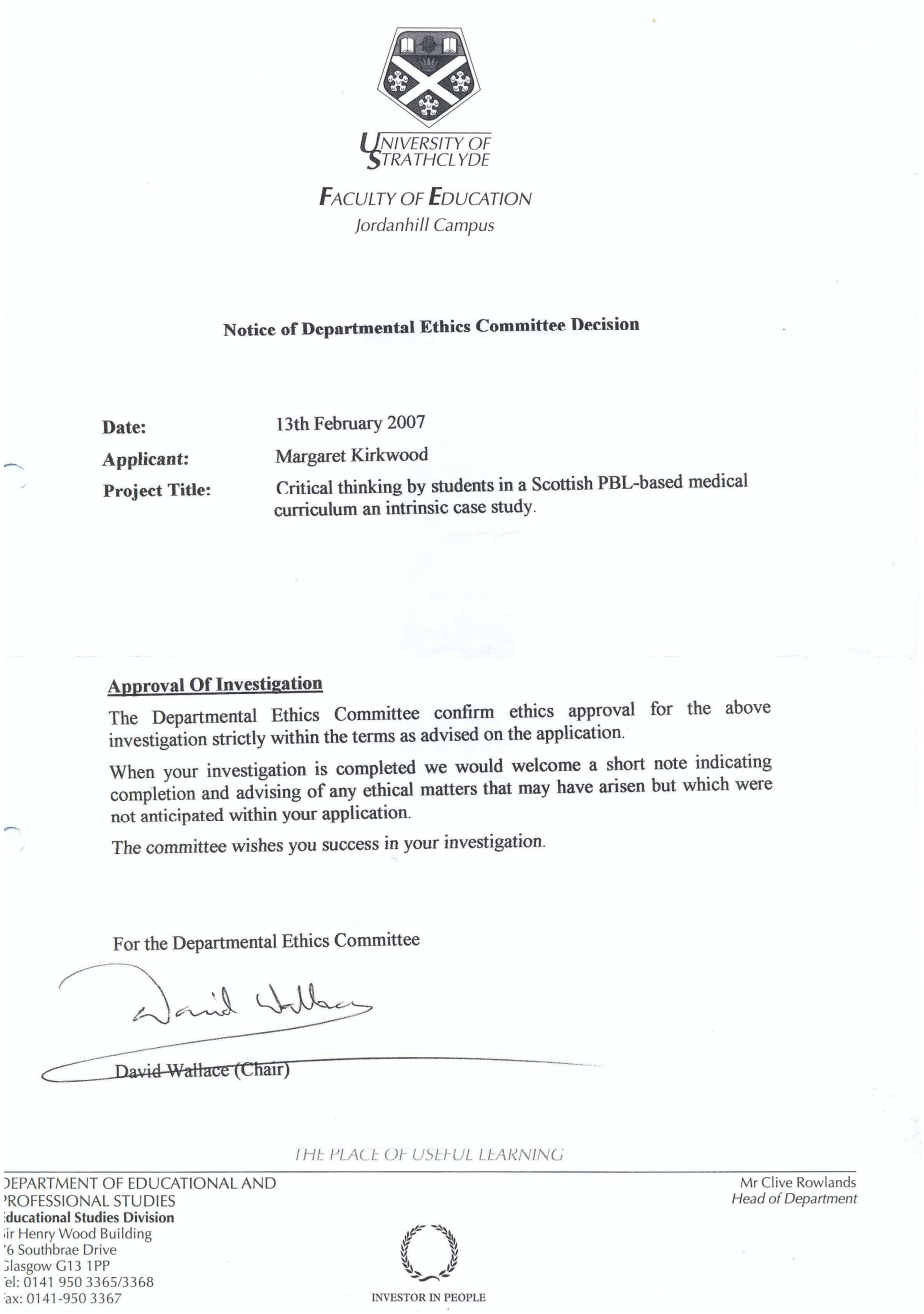
Letter of ethical approval. Appendix A.



UNIVERSITY OF STRATHCLYDE

FACULTY OF EDUCATION
Jordanhill Campus

Notice of Departmental Ethics Committee Decision

Date: 13th February 2007
Applicant: Margaret Kirkwood
Project Title: Critical thinking by students in a Scottish PBL-based medical curriculum an intrinsic case study.

Approval Of Investigation

The Departmental Ethics Committee confirm ethics approval for the above investigation strictly within the terms as advised on the application.

When your investigation is completed we would welcome a short note indicating completion and advising of any ethical matters that may have arisen but which were not anticipated within your application.

The committee wishes you success in your investigation.

For the Departmental Ethics Committee

David Wallace (Chair)

THE PLACE OF USEFUL LEARNING

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Mr Clive Rowlands
Head of Department

INVESTOR IN PEOPLE

Appendix A. Letter of ethical approval*: Copy of the ethical approval for this study Granted by the University of Strathclyde, on 13th February 2007. The named Principal Investigator was the original supervisor, Dr Margaret Kirkwood. The study was originally designed to be an intrinsic case study, but evolved over time, as indicated in Section 5.3. Minor amendments were approved by the Ethics Committee (not shown).*

Email regarding ethical approval requirements of institution where study was undertaken. **Appendix B**

-----Original Message-----
From: "Dr Susan Jamieson" <sj1m@clinmed.gla.ac.uk>
To: ammn1r@clinmed.gla.ac.uk
Date: Sat, 31 Mar 2007 20:38:51 +0000
Subject: Re: Re: Advice on ethics application, please

Dear Anne Marie,

This is great news! Thank you. I'll send a copy of the documentation next week - to you or to Alice? Or both?

Best wishes,
Susan.

-----Original Message-----
From: "Dr Anne Marie McNicol" <ammn1r@clinmed.gla.ac.uk>
To: sj1m@clinmed.gla.ac.uk
Date: Sat, 31 Mar 2007 19:10:57 +0100
Subject: Re: Advice on ethics application, please

Since you are a student in Strathclyde, your approval should be from there. It would be appropriate for us to have copies of the documentation for our files, but we do not have to give separate approval.

Anne Marie

Appendix B. Email regarding ethical approval requirements of institution where the study was undertaken: *Email correspondence from the then Chair of the Research Ethics Committee in the institution where the study was undertaken, confirming there was no requirement for it to grant separate ethical approval.*

Consent form for student participants. **Appendix C.**

[Institution's Logo]

Study centre: University of XXXX

Title of project: Critical thinking by students in a Scottish PBL-based medical curriculum: an intrinsic case study.

Principal Researcher: Dr. Susan Jamieson

Please check box

1. I confirm that I have read and understood the information sheet ☐
2. I understand that my participation is voluntary and that participation (or otherwise) will in no way affect my academic progress ☐
3. I agree to take part in the above study ☐

Name (printed) _____

Signature _____

Date _____

Appendix C. Consent form for student participants: *Copy of the consent form distributed to and completed by student participants; an equivalent form was completed by facilitators who participated in the study (not shown).*

Letter of invitation Appendix D.

[Institution's Logo]

Tuesday, 15th January 2008.

Dear Student [Colleague],

Research study - Critical thinking by students in a PBL-based medical curriculum: an intrinsic case study.

I'm writing in the hope that you will agree to participate in this research study, whose purpose is to look for evidence of critical thinking by students in a PBL-based medical curriculum. There are three aspects to this study and you are being asked to participate in a specific aspect; see the enclosed information sheet for further details. If, having read the information sheet, you wish to participate, I would be grateful if you would sign the enclosed consent form. I look forward to working with you.

Regards,

Susan Jamieson

Dr.

Dr.Susan Jamieson
BSC (Hons), PGCE (HE), Ph.D.
Senior University Teacher

[Postal address included]
[Telephone number included]
[email address included]

***Appendix D. Letter of invitation**: Copy of the letter of invitation that was distributed to prospective participants.*

Information sheet Appendix E.

Critical thinking by students in a PBL-based medical curriculum: an intrinsic case study.

You are being invited to take part in a research study. Before you decide to take part it is important for you to understand why the research is being done and what it will involve. Please take the time to read the following information carefully and discuss it with others if you wish. Take time to decide whether or not you wish to take part.

What is the purpose of the study?

The purpose of this study is to look for evidence of critical thinking by students in a problem-based learning (PBL)-based medical curriculum.

Critical thinking is considered to underpin clinical reasoning and judgement and therefore it would seem essential that medical curricula give students the opportunity to learn and/or develop critical thinking ability. Consistent with this, acquisition of critical thinking ability is a learning outcome specified by the Scottish Deans' Medical Curriculum Group.

Since the mid-90s, several UK medical schools have adopted PBL as their major learning and teaching methodology. Many claims are made for PBL, including that it fosters critical thinking. This study will look for evidence to support that claim.

There are three different components to the study, and you are being asked to take part in the '**Discourse Analysis of a PBL Tutorial**'. Essentially, the dialogue during a PBL tutorial will be recorded and later analysed for phrases indicative of critical thinking.

Why have I been chosen to participate?

The researcher selected groups whose facilitators were previously willing to be peer-observed by trainee facilitators; however, it is necessary to gain the informed consent of the facilitator and each group member before the group may participate.

Do I have to take part?

Your participation is entirely voluntary. If you do decide to take part, you will be asked to submit a signed consent form to confirm that you have read and understood this information sheet, and consent to participating in the study.

Any one member of the PBL group (or the facilitator) has right of veto; if even one person withholds consent, the group may not participate in the study.

Your decision will in no way affect your academic progress, or the grades you achieve.

What will happen to me if I take part?

- Video/DVD recording equipment and microphones will be set up in a PBL room or some other suitable venue
- With your PBL group and facilitator, you will meet with the researcher 15 minutes prior to a standard PBL tutorial, to give the audio-visual technician time to set up
- The PBL session should be conducted as usual; both halves of the PBL tutorial will be video/DVD-recorded
- The researcher will not be present during the filming, but an audiovisual technician will help with any problems that arise during the recording

What do I have to do?

If you agree to take part, you should sign the accompanying consent form and return it to the researcher in the enclosed envelope (via the Year 1 Secretary, or the General Office). If everyone in the PBL group gives written consent, the researcher will contact you all to arrange a mutually convenient time for the recording session.

What are the possible disadvantages and risks of taking part?

There are no personal disadvantages or risks should you choose to take part, other than the time it will take (about 15-30 minutes longer than a usual PBL).

What are the possible benefits of taking part?

There are no specific benefits to you, personally, although you may find the exercise interesting. Also, as a participant you will – in due course – receive a report on the findings of the study. There is potential benefit to the undergraduate medical school at Glasgow: evidence that the PBL process provides opportunities for developing critical thinking.

Will my taking part in this study be kept confidential?

Clearly, your participation in the video/DVD will not be confidential. However, you will have anonymity in any report or publication arising from this study, since the phrases from the PBL dialogue will not be identified as having come from a particular individual.

Further information

Further information may be obtained from Dr. Susan Jamieson [email provided]

Appendix E. Information Sheet*: Copy of the information sheet distributed to prospective participants. The title reflects the original study design, in which one aspect was analysis of transcribed PBL discourses for evidence of critical thinking by medical students during PBL tutorials; the information in this sheet pertained specifically to that aspect of the study and to the actual research described in this thesis.*

Appendix F: Adapted CoI Framework: Coding Scheme (i)				
Element	**Categories**	**Indicators (examples)**	**Notes to aid coding**	**Codes**
Cognitive presence	Triggering event	Sense of puzzlement.	-	C/Trig/P
		Identification of gap in knowledge.	Must imply intention to 'fill gap'.	C/Trig/G
		Identification of issue to be explored.	-	C/Trig/I
	Exploration/ information gathering	Use of resource during tutorial - e.g., dictionary.	-	C/Info/R
		Seeking information by asking direct Q.	-	C/Info/Q
		Seeking confirmation.	Of information the speaker seems to regard as known. E.g., isn't it?	C/Info/Cf
		Seeking clarification.	Asking someone to repeat/clarify what they have said.	C/Info/Cl
		Information exchange between group members.	Relay of information – not coded as integration, if source is not made explicit or implicit.	C/Info/X
		Direct response to peer's question.	-	C/answer
	Exploration/ creativity	Hypothesis formation.	Possible explanations – element of doubt on part of speaker [it may be].	C/Hyp
		Providing explanations.	Probable explanations – degree of certainty implied in wording or tone.	C/Xpln
		Offering different perspective/suggestion.	Follows an assertion, hypothesis or explanation provided by a peer.	C/Alt
		Offering examples (exemplification).	Using own thinking to exemplify, rather than re-iterating examples from a textbook	C/Exemp
		Making an analogy.	-	C/Anal

Appendix F: Adapted CoI Framework: Coding Scheme (ii)				
Element	**Categories**	**Indicators (examples)**	**Notes to aid coding**	**Codes**
Cognitive presence	Integration	Connecting ideas.	Ideas relating to the issue at hand.	C/Int/I
		Connecting to existing knowledge.	Link to knowledge we can assume is from course, even where this is not made explicit.	C/Int/K
		Relating to previous scenarios, parts of course.	-	C/Int/C
		Relating to question raised by peer.	-	C/Int/Q
		Relating to comment by peer.	-	C/Int/P
		Linking to previous experience outwith course.	Personal experiences, or those of friends or family.	C/Int/Xp
		Relating to empirical evidence.	Journal articles, clinical trials.	C/Int/Ev
		Link to unspecified resource.	For example, unspecified health report.	C/Int/R
	Resolution	Application of new ideas.	-	C/Res/I
		Reflection on the consequences of new understanding.	An element of prediction, but greater certainty than with an hypothesis or explanation.	C/Res/C
		Forming a judgment/ Conclusion.	-	C/Res/J
		Reflection on thinking (meta-cognition).	Relating to meta-cognitive knowledge, meta-cognitive experience, and/or appraisal or judgment of one's thinking.	C/Res/M
		Reflection on learning (self-regulation).	Relating to aspect of how students do, or might learn.	C/Res/L
	Negative manifestation	Placing a limit on learning.	References to have 'done' or 'covered' a topic.	C/Neg/L

Appendix F: Adapted CoI Framework: Coding Scheme (iii)				
Element	**Categories**	**Indicators (examples)**	**Notes to aid coding**	**Codes**
Social presence	Emotional expression	Humour/joke.	-	S/Emot/H
		Laughter.	-	S/Emot/L
		Personal perspective/feelings.	-	S/Emot/P
	Open communication	Risk-free expression.	Students not cowed by/in awe of facilitator (or video/recorder).	S/Risk-
	Group cohesion	Encouraging collaboration.	Inclusive remark, 'we'.	S/Chsn/C
		Co-operation.	E.g., acquiescing with Chair's direction).	S/Chsn/Cp
		Re-iteration (e.g., for benefit of scribe).		S/Chsn/Re
		Inter-personal support.	E.g., empathising, encouraging.	S/Chsn/IP
		Shared identity.	-	S/Chsn/ID
		Giving support for ideas.	Not just 'yeah' – needs to paraphrase, exemplify idea, etc.	S/Supp
		Straightforward agreement/ concurrence in relation to process.	-	S/Agree
	Negative manifestation of social presence	Teasing or undermining peer.		S/Teas
		Unduly judgemental/inappropriate		S/Judg
		Interruption.		S/Inter
		Group dynamic impacts negatively on CT.		S/Dynam
		Lack of cohesion (e.g., ignoring or questioning Chair's direction).		S/Lack

Appendix F: Adapted CoI Framework: Coding Scheme (iv)				
Element	**Categories**	**Indicators (examples)**	**Notes to aid coding**	**Codes**
Teaching Presence	Didactic	Giving advice (e.g., on issues to leave for a future date, potential issues to be addressed).	-	T/advice
		Didactic intervention [teaching in the typical sense].	-	T/Did
		Direct response to question.	-	T/answer
	Facilitating process	Prompts to stick to PBL process.	-	T/Fac/P
		Prompts to Chair or Scribe or Group.	-	T/Fac/C,S,G
		Encouraging good group dynamic.	-	T/Dynam
		Prompts re. time.	-	T/Time
	Facilitating understand-ing	Asking for clarification.	Of what someone means.	T/Und/Cl
		Providing clarification.	Must build on what student has said – like developmental support, but purpose is clarifying rather than supporting.	T/Und/PrCl
		Seeking support for/confirmation of one's own understanding of a concept.	As opposed to confirmation of a fact – this makes assumptions about students' perspective about 'facts' vs. their personal constructions.	T/Und/S
		Asking questions.		T/Und/Q
		Probing with further questions.	Keeps pushing to get at depth of understanding.	T/Und/P
		Asking for justification.	Asking for reasons.	T/Und/Jst
		Helping group to identify conflicting information.	E.g., by giving information that contradicts assertions.	T/Cnfl
		Prompting further reflection.	-	T/Und/R
		Prompting integration of material.	Referring to earlier parts of course.	T/Und/Int

Appendix F: Adapted CoI Framework: Coding Scheme (v)				
Element	**Categories**	**Indicators (examples)**	**Notes to aid coding**	**Codes**
Teaching presence	Facilitating development	Facilitating meta-cognition.	Encouraging students to be explicit about their thinking.	T/Dev/M
		Facilitating learning.	E.g., encouraging discussion about study techniques, note-taking.	T/Dev/L
		Facilitating reflection.		T/Dev/R
		Giving feedback to individual.		T/Dev/I
		Giving feedback to group.		T/Dev/G
		Giving support to the group (e.g., by confirming their thinking).	Gives information, but not coded as didactic if responding to group's own ideas. E.g., anecdote, correction, exemplification.	T/Dev/S
		Role modelling.	E.g., acknowledging uncertainty, curiosity.	T/Dev/ Model
	Structure	Reference to the Steps (PBL Process).		T/steps
		Reference to. Questions set in Step 4.	Utterances that are simple statements of (possible) questions (to be) set by the group.	T/Q4
		Reference to roles.	-	T/Roles
	Resource	Provision of PBL scenario.	-	T/scenario
		Use of dictionary.	-	T/Dict
		Provision of prompts (photographs).	-	T/Prompt
		Reference to forthcoming learning opportunities (labs, lectures).	Since reference to session that has already taken place would be interpreted as integration.	T/LOs
		Reference to some other resource.	-	T/resource

Appendix F: Adapted CoI Framework: Coding Scheme (vi)				
Element	**Categories**	**Indicators (examples)**	**Notes to aid coding**	**Codes**
Teaching presence	Impediment to developing CP	Missed opportunity.	Point in discourse where opportunity to facilitate CT was missed.	T/MO
		Inhibiting CT.	Utterance that has the effect of inhibiting CT or drawing it to a close.	T/Inhib
	Other negative example	Difficulty locating or using a resource.	-	T/Neg/ Resource
		Undermining a specific discipline/ specialty.	-	T/Neg/D
		Undermining group dynamic.	-	T/Neg/Dyn
		Undermining PBL process.	-	T/Neg/P
		Undermining PBL as a methodology.	-	T/Neg/PBL
		Negative comment about scenario.	-	T/Neg/Scen
		Undermining students' meta-cognition.	-	T/Neg/M
		Undermining students' learning.	-	T/Neg/L
Aspect of study	Research	-	Reference to video, tape, etc	Research

Appendix F. Adapted Community of Inquiry (CoI) Framework - Coding Scheme*: Representation of the final coding scheme, adapted from Garrison et al's (2000) CoI Framework and refined during the iterative process of data analysis. The coding scheme contains the three elements - or constructs - of cognitive, social and teaching presence; categories mapping to these elements; examples of indicators for each category; notes to elaborate on the indicators and hence aid coding; and the shorthand codes that were used in this study.*

Appendix G: Example of aligned utterances and coding justifications [Group Y1C3, transcript 2]			
Utter-ance	Indiv-idual	Content	CODE
24	M3	Shall we move on then to main issues?	T/steps; T/Fac/P; S/Chsn/C
24	M3	• Beginning the 2nd of the Glasgow Steps (identifying main issues) & … • Facilitates the process • social presence manifest in encouraging collaboration (his use of 'shall we?')	T/steps T/Fac/P S/Chsn/C
25	F3	Stroke [laughter].	C/Trig/I; S/Emot/L
25	F3	• Identification of an issue to be explored - without brainstorming their existing understanding, they don't necessarily realise this constitutes a problem or a gap in their knowledge - hence new code • Social presence as manifest in laughter	C/Trig/I S/Emot/L
26	F1	Long term effects.	C/Trig/I
26	F1	• Identification of issue to be explored	C/Trig/I
27	F3	Blood supply to the brain.	C/Trig/I
27	F3	• Identification of issue to be explored	C/Trig/I
28	M4	Whoa, whoa, whoa, slow down a bit [laughter]. Stroke, what?	T/Fac/G; S/Emot/L
28	M4	• Scribe prompts group members to slow down … • …provoking laughter	T/Fac/G S/Emot/L
29	M3	Long term effects.	S/Chsn/Re
29	M3	• Re-iteration of issue identified in utterance 26	S/Chsn/Re
30	M4	No, you said something before that.	T/Fac/G
30	M4	• Scribe prompting group member	T/Fac/G

Appendix G. Example of aligned utterances and coding justifications [Group Y1C3, transcript 2]*: Excerpt of transcript in which Year 1 PBL Group C3 was undertaking PBL steps 1 to 5, for a scenario about stroke. The excerpt presents utterances 24 to 30, inclusive. Immediately below each utterance is a justification for the coding decision(s) relating to the utterance. The allocated codes are presented in the right-hand column.*

Characteristics of PBL tutorials in this study. Appendix H.

Characteristics of PBL tutorials analysed in this study.			
Group	**Year of study**	**Topics in PBL scenario**	**PBL steps**
Y1C3	1	Care of the elderly	6 & 7
		Stroke	1 to 5
Y1B2	1	Care of the elderly	6 & 7
		Stroke	1 to 5
Y1B3	1	Thermoregulation & malaria	6 & 7
		Pneumonia	1 to 5
Y1A3	1	Thermoregulation & malaria	6 & 7
		Pneumonia	1 to 5
Y2B3	2	Bilirubin metabolism & viral hepatitis	6 & 7
		Gallstones & liver function	1 to 5
Y2C3	2	Bilirubin metabolism & viral hepatitis	6 & 7
		Gallstones & liver function	1 to 5

Appendix H. Characteristics of the PBL discourses in this study*: Information provided includes the code for each group in the study, where, for example, Y1C3 denotes Year 1 PBL Group C3; the students' year of study; the topics featured in the PBL scenario; and the specific steps of the PBL process followed in each discourse.*

Appendix J. Indicators identified in specific PBL steps, for each PBL group (i).

Element	Category	Indicator	Code	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Cognitive presence	**Trigger**	Puzzle	C/Trig/P			**Yes** **Yes**			**Yes** **Yes**	
		Gap	C/Trig/G	**Yes** **Yes**		**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes**		**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes**
		Issue	C/Trig/I		**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes**				
	External Exploration	Info from resource	C/Info/R	**Yes**						
		Info from question	C/Info/Q	**Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes**		**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes**
		Seeking clarification of what someone said	C/Info/Cl	**Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes**		**Yes** **Yes** **Yes** **Yes** **Yes**	

KEY:

Colour code for PBL Group:

Y1C3
Y1B2
Y1B3
Y1A3
Y2B3
Y2C3

Appendix J. Indicators identified in specific PBL steps, for each PBL group (ii).

Element	Category	Indicator	Code	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	KEY:
Cognitive presence	**External Exploration**	Seeking confirmation	C/Info/Cf	**Yes** **Yes** **Yes** **Yes** **Yes**	 **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	 **Yes** **Yes** **Yes**		**Yes** **Yes** **Yes** **Yes** **Yes**		**Colour code for PBL Group:** **Y1C3** **Y1B2** **Y1B3** **Y1A3** **Y2B3** **Y2C3**
		Info exchange	C/Info/X	 **Yes** **Yes** **Yes** **Yes**	 **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	 **Yes** **Yes**		**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	 **Yes** **Yes** **Yes**	
		Direct answer to question	C/answer	 **Yes**		**Yes** **Yes** **Yes** **Yes** **Yes**	 **Yes**		 **Yes** **Yes**		
	Internal exploration	Hypothesis formation	C/Hyp		 **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**			**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	 **Yes**	

Appendix J. Indicators identified in specific PBL steps, for each PBL group (iii).

Element	Category	Indicator	Code	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	KEY:
Cognitive presence	**Internal exploration**	Tentative explanation	C/Xpln		**Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**			**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	**Yes**	**Colour code for PBL Group:** **Y1C3** **Y1B2** **Y1B3** **Y1A3** **Y2B3** **Y2C3**
		Alternative perspective/ suggestion	C/Alt		**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes**		**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes**	
		Exemplificat -ion	C/Exemp			**Yes** **Yes** **Yes**			**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**		
		Offering an analogy to explain something	C/Analogy			**Yes**			**Yes** **Yes**		

Appendix J. Indicators identified in specific PBL steps, for each PBL group (iv).

Element	Category	Indicator	Code	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	KEY:
Cognitive presence	**Integration**	Integration with idea	C/Int/I		**Yes**	**Yes** **Yes** **Yes** **Yes**			**Yes** **Yes** **Yes** **Yes**		**Colour code for PBL Group:** **Y1C3** **Y1B2** **Y1B3** **Y1A3** **Y2B3** **Y2C3**
		Existing knowledge	C/Int/K		**Yes**	**Yes** **Yes** **Yes**			**Yes** **Yes**		
		Something from course	C/Int/C	**Yes**	**Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes**	**Yes**	**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes**	
		Question from peer	C/Int/Q			**Yes** **Yes**			**Yes**		
		Comment from peer	C/Int/P	**Yes**	**Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	**Yes**		**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	**Yes**	

Appendix J. Indicators identified in specific PBL steps, for each PBL group (v).

Element	Category	Indicator	Code	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	KEY:
Cognitive presence	**Integration**	Tentative explanation	C/Xpln		**Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**			**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	**Yes**	**Colour code for PBL Group:** **Y1C3** **Y1B2** **Y1B3** **Y1A3** **Y2B3** **Y2C3**
		Experience from out-with course	C/Int/Xp		**Yes**	**Yes** **Yes** **Yes** **Yes** **Yes**			**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	**Yes**	
		Evidence	C/Int/Ev			**Yes**			**Yes** **Yes**		
		Integration with material from unspecified resource	C/Int/R			**Yes**			**Yes** **Yes**		
	Resolution	Application of ideas	C/Res/I			**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes**		**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes**	

Appendix J. Indicators identified in specific PBL steps, for each PBL group (vi).

Element	Category	Indicator	Code	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	KEY:
Cognitive presence	**Resolution**	Reflection on con-sequences	C/Res/C			**Yes** **Yes** **Yes** **Yes**			**Yes** **Yes** **Yes** **Yes**	**Yes**	**Colour code for PBL Group:** **Y1C3** **Y1B2** **Y1B3** **Y1A3** **Y2B3** **Y2C3**
		Conclusion/ judgment	C/Res/J			**Yes** **Yes** **Yes** **Yes**			**Yes** **Yes** **Yes**		
		Reflection on thinking (meta-cognition)	C/Res/M	**Yes**	**Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes**		**Yes** **Yes** **Yes** **Yes**	**Yes** **Yes**	
		Reflection on learning/ SRL	C/Res/L		**Yes**	**Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes**		**Yes** **Yes** **Yes**	**Yes** **Yes**	
	Negative manifest-ation of cognitive presence	Limiting learning (it's been covered, 'need to know')	C/Neg/L		**Yes**	**Yes** **Yes**	**Yes** **Yes**		**Yes** **Yes**	**Yes**	

Appendix J. Indicators identified in specific PBL steps, for each PBL group (vii).

Element	Category	Indicator	Code	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Social presence	**Emotional expression**	Humour	S/Emot/H	Yes Yes Yes	Yes Yes Yes Yes	Yes Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes	Yes	Yes Yes Yes Yes Yes Yes	Yes Yes
		Laughter	S/Emot/L	Yes Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes Yes	Yes	Yes Yes Yes Yes Yes Yes	Yes
		Personal info or opinion	S/Emot/P	Yes	Yes	Yes Yes Yes Yes Yes			Yes Yes Yes Yes Yes	Yes
	Open communication	Risk-free expression	S/risk-			Yes Yes	Yes		Yes Yes Yes	
	Group cohesion	Collaborat-ive	S/Chsn/C	Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes		Yes Yes Yes Yes Yes Yes	

KEY:

Colour code for PBL Group:

Y1C3
Y1B2
Y1B3
Y1A3
Y2B3
Y2C3

Appendix J. Indicators identified in specific PBL steps, for each PBL group (viii).

Element	Category	Indicator	Code	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	KEY:
Social presence	**Cohesion**	Cooperation	S/Chsn/Cp	**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes**		**Yes** **Yes** **Yes** **Yes** **Yes**		**Colour code for PBL Group:** **Y1C3** **Y1B2** **Y1B3** **Y1A3** **Y2B3** **Y2C3**
		Re-iteration	S/Chsn/Re	**Yes** **Yes** **Yes**	**Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes**		**Yes**		
		Inter-personal	S/Chsn/IP	**Yes** **Yes** **Yes** **Yes**	**Yes**	**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes**		**Yes** **Yes**		
		Shared identity	S/Chsn/ident						**Yes**		
		Supportive of idea - paraphrases it	S/Supp	**Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes**		**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes**	

Appendix J. Indicators identified in specific PBL steps, for each PBL group (ix).

Element	Category	Indicator	Code	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Social presence	**Cohesion**	Supportive of aspect of process	S/Agree	**Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes**	**Yes**	**Yes** **Yes** **Yes**	
	Negative manifestation of social presence	Teasing or under-mining peer	S/Teas	**Yes** **Yes**	**Yes**	**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes**		**Yes** **Yes**	
		Judgmental /inappropr-iate remarks	S/Judg			**Yes**			**Yes** **Yes**	
		Interruption	S/Interr	**Yes**		**Yes**			**Yes**	
		Group dynamics impacts negatively on CT	S/Dynam	**Yes**		**Yes** **Yes** **Yes**	**Yes**		**Yes**	
		Lack of cohesion	S/Lack	**Yes** **Yes** **Yes**	**Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes**		**Yes** **Yes** **Yes** **Yes** **Yes**	

KEY:

Colour code for PBL Group:

Y1C3
Y1B2
Y1B3
Y1A3
Y2B3
Y2C3

Appendix J. Indicators identified in specific PBL steps, for each PBL group (x).

Element	Category	Indicator	Code	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	KEY: Colour code for PBL Group: Y1C3 Y1B2 Y1B3 Y1A3 Y2B3 Y2C3
Teaching presence	**Directive**	Gives advice	T/Advice	**Yes**	**Yes**	**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes**		**Yes** **Yes** **Yes**	**Yes**	
		Provides information in didactic manner	T/Didactic	**Yes**		**Yes** **Yes** **Yes**	**Yes**		**Yes** **Yes** **Yes** **Yes**		
		Facilitator provides answer to drect question	T/answer	**Yes**		**Yes** **Yes** **Yes**	**Yes**		**Yes** **Yes** **Yes** **Yes**		
	Facilitating process – by student (S) or facilitator (F)	Facilitating process	T/Fac/P	**Yes (S)** **Yes (F/S)** **Yes (S, F)** **Yes (FS)**	**Yes (S)** **Yes (F/S)** **Yes (F)** **Yes (S)** **Yes (S)** **Yes (S)**	**Yes (S)** **Yes (S,F)** **Yes (S,F)** **Yes (S)** **Yes (S)** **Yes (S)**	**Yes (S)** **Yes (S, F) Yes (S,F)** **Yes (F)**	**Yes (S)**	**Yes (F,S)** **Yes (F,S)** **Yes (S,F)** **Yes (S)** **Yes (F,S)** **Yes (F, S)**	**Yes (S,F)** **Yes (F)** **Yes (S,F)** **Yes (F)**	

Appendix J. Indicators identified in specific PBL steps, for each PBL group (xi).

Element	Category	Indicator	Code	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	KEY: Colour code for PBL Group:
Teaching presence	**Facilitating process** – by student (S) or facilitator (F)	Prompt to Chair	T/Fac/C	**Yes** **Yes**		**Yes**			**Yes (F/S)** **Yes** **Yes** **Yes (F)**		**Y1C3** **Y1B2** **Y1B3** **Y1A3** **Y2B3** **Y2C3**
		Prompt to Scribe	T/Fac/S	**Yes (S)** **Yes (S)**	**Yes (S)** **Yes (S)** **Yes (S)**	**Yes (S)** **Yes (S)** **Yes (S)** **Yes (S)**					
		Prompt to group	T/Fac/G	**Yes**	**Yes (S)** **Yes (S)** **Yes (S)**	**Yes (S)** **Yes (S)** **Yes (S)**	**Yes** **Yes**		**Yes (S)** **Yes**		
		Encourag-ing a better dynamic	T/Fac/Dynam			**Yes**					
		Eye to time	T/Fac/Time			**Yes (S)** **Yes (S)**				**Yes**	

Appendix J. Indicators identified in specific PBL steps, for each PBL group (xii).

Element	Category	Indicator	Code	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	KEY: Colour code for PBL Group:
Teaching presence	**Facilitating understand-ing** – by student (S) or facilitator (F)	Asking for clarification of what someone means	T/Und/Cl			**Yes (S)** **Yes (S)**					**Y1C3** **Y1B2** **Y1B3** **Y1A3** **Y2B3** **Y2C3**
		Providing clarification on previous input	T/Und/PrCl	**Yes (S)**	**Yes (S)**	**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes**		**Yes (S)** **Yes (S)** **Yes (S)** **Yes (S)** **Yes (S, F)**		
		Seeking support for one's own understand-ing	T/Und/S	**Yes**	**Yes (S)**	**Yes** **Yes** **Yes** **Yes**	**Yes (S)**		**Yes** **Yes** **Yes** **Yes**		
		Asks questions - inquiring	T/Und/Q		**Yes**	**Yes** **Yes (S,F)** **Yes (F)** **Yes (F,S)** **Yes (F)** **Yes (F)**	**Yes**		**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**		

Appendix J. Indicators identified in specific PBL steps, for each PBL group (xiii).

Element	Category	Indicator	Code	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	KEY: Colour code for PBL Group: Y1C3 Y1B2 Y1B3 Y1A3 Y2B3 Y2C3
Teaching presence	**Facilitating understand-ing** – by student (S) or facilitator (F)	Asks probing questions - testing understand-ing	T/Und/P		Yes	Yes Yes Yes	Yes		Yes Yes Yes Yes Yes		
		Asking for justification	T/Und/Jstf			Yes					
		Helping group to identfy conflicting info	T/Cnfl			Yes Yes Yes Yes Yes			Yes (S) Yes (S) Yes (S) Yes (S) Yes (S)		
		Prompting further reflection	T/Und/R		Yes	Yes					
		Prompting integration.	T/Und/Int			Yes Yes					
	Facilitating development	Facilitating meta-cognition	T/Dev/M			Yes Yes	Yes		Yes	Yes	
		Facilitating reflection on learning	T/Dev/L			Yes					

Appendix J. Indicators identified in specific PBL steps, for each PBL group (xiv).

Element	Category	Indicator	Code	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Teaching presence	**Facilitating development**	Giving feedback to individual	T/Dev/I	Yes		Yes Yes Yes	Yes		Yes Yes	
		Giving feedback to group	T/Dev/G			Yes Yes	Yes Yes		Yes Yes	
		Providing support for ideas	T/Dev/S		Yes Yes Yes Yes	Yes Yes Yes Yes Yes	Yes Yes		Yes Yes Yes Yes Yes Yes	Yes Yes
		Facilitating further reflection	T/Dev/R							Yes Yes
		Facilitator development by modelling learning behaviour	T/Dev/ Model			Yes			Yes Yes	
	Structure	Reference to steps	T/steps	Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes	Yes Yes Yes	Yes	Yes Yes Yes Yes Yes Yes	Yes Yes Yes

KEY:

Colour code for PBL Group:

Y1C3
Y1B2
Y1B3
Y1A3
Y2B3
Y2C3

Appendix J. Indicators identified in specific PBL steps, for each PBL group (xv).

Element	Category	Indicator	Code	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	KEY: Colour code for PBL Group:
Teaching presence	**Structure**	Reference to Q set in step 4	T/Q4				**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**				**Y1C3** **Y1B2** **Y1B3** **Y1A3** **Y2B3** **Y2C3**
		Reference to curriculum	T/Roles				**Yes**				
	Resource	Reference to scenario	T/scen	**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	 **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	 **Yes** **Yes** **Yes** **Yes**		 **Yes** **Yes** **Yes**	 **Yes**	
		Refence to dictionary	T/dict	**Yes** **Yes** **Yes** **Yes**		**Yes** **Yes** **Yes**					
		Reference to prompt - e.g., photo	T/prompt						**Yes**		
		Reference to Facilitator role	T/role			**Yes**					

Appendix J. Indicators identified in specific PBL steps, for each PBL group (xvi).

Element	Category	Indicator	Code	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Teaching presence	**Resource**	Reference to, e.g., book, diagram	T/resource		**Yes**	**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes** **Yes**
	Negative manifestat-ions of teaching presence	Inability to locate/use resource	T/Neg Resource/			**Yes**			**Yes** **Yes**	**Yes** **Yes**
		Missed opportunity to facilitate aspect of CT	T/MO	**Yes**		**Yes** **Yes** **Yes** **Yes**	**Yes**		**Yes** **Yes** **Yes** **Yes** **Yes**	**Yes** **Yes** **Yes**
		Utterance that inhibits CT or draws it to a close	T/Inhib			**Yes**			**Yes** **Yes**	
		Undermining a specific discipline	T/Neg/D				**Yes**		**Yes** **Yes**	
		Undermining the PBL process	T/Neg/P	**Yes** **Yes**	**Yes** **Yes** **Yes**	**Yes** **Yes** **Yes**	**Yes** **Yes**	**Yes**	**Yes** **Yes**	

KEY:

Colour code for PBL Group:

Y1C3
Y1B2
Y1B3
Y1A3
Y2B3
Y2C3

Appendix J. Indicators identified in specific PBL steps, for each PBL group (xvii).											
Element	**Category**	**Indicator**	**Code**	**Step 1**	**Step 2**	**Step 3**	**Step 4**	**Step 5**	**Step 6**	**Step 7**	**KEY:** **Colour code for PBL Group:** **Y1C3** **Y1B2** **Y1B3** **Y1A3** **Y2B3** **Y2C3**
Teaching presence	**Negative manifestat-ions of teaching presence**	Undermining dynamic	T/Neg/Dynam						**Yes**		
		Undermining PBL	T/Neg/ PBL							**Yes**	
		Negative comment in relation to scenario	T/Neg/ Scen			**Yes**					
		Undermining students' meta-cognition	T/Neg/M								
		Under-mining students' learning	T/Neg/L				**Yes**				
NOT CoI	**Research**	Comment related to study	Research	**Yes**		**Yes**	**Yes** **Yes**				

Appendix J: Indicators indentified in PBL steps: *Tabulated, visual representation of indicators identified in each step of the PBL process, for each PBL group in this study. The table lists the elements, categories and indicators in the adapted CoI framework (see 3.4), as well as the shorthand codes for indicators (Appendix F). Where an indicator was identified in a specific step of the PBL process, the word 'yes' has been entered in the table. Each PBL group is represented by a different colour, specified in the key. Thus, Y1C3 = red; Y1B2=brown; Y1B3 = turquoise; Y1A3 = green; Y2B3 = pink; and Y2C3 = blue. Specific indicators of soft-scaffolding teaching presence were sometimes attributed to students (S) and/or to the facilitator (F).*

Appendix K: Excerpt from discourse by Group Y1B2; during brainstorming (i). **CP= cognitive presence; SP= social presence, TP=teaching presence.**			
U	**By**	**Utterance**	**Interpretation**
163	M1	The common carotid [artery] splits into your internal [and] external.	He 'provides explanation': **external exploration** category of CP.
170	F4	…so what you're saying [is] that this one's going to split into your internal and your external.	She 'seeks support' for her understanding: **facilitating understanding** category of TP
171	?	…no, the nerve splits up, not the vessels	Her peer 'provides clarification', thereby **facilitating understanding**: example of soft scaffolding TP.
173	Fac	What does <u>anybody</u> know about this?	The facilitator addresses the 'group dynamic', trying to widen the discourse to include <u>other students</u>; an indicator of **facilitating process**, a type of soft scaffolding TP.
174	M3	I thought the vessels crossed over.	**External exploration** category of CP, since provision of 'information', but also possibly **resolution**, because it reflects 'meta-cognitive knowledge'.
176	M4	The blood vessels cross over in the brain …	**External exploration** category of CP; 'information exchange'.

Appendix K: Excerpt from discourse by Group Y1B2; during brainstorming (ii). **CP= cognitive presence; SP= social presence, TP=teaching presence.**			
U	**By**	**Utterance**	**Interpretation**
177	M3	No. Before they get into the brain, because I saw an operation when a woman had already had a series of mini-strokes and it was her right common carotid artery … he was doing a stent operation and he said that that was because it was going to affect the left hand side of her brain.	**Integration** category of CP, via linking to 'experience outwith the course'.
178	F1	So do you think about here they are going to cross over?	Interpreted as 'hypothesis formation', and hence an example on the **internal exploration** category of CP. She was effectively saying "They may cross over here".
180	F2	Where do you think they cross?	**External exploration** category of CP, via 'seeking answer'.
181	M3	I saw the head when I was doing anatomy dissection … I definitely saw a sort of carotid going like this, as if it was crossing over …	**Integration** category of CP, via linking to experience elsewhere on the 'course'.
182	F2	So there's a possible crossover.	By summarising the discussion, she **facilitates process**, hence TP; and she 'provides support' for his idea, hence the **cohesion** category of SP.
184	M3	Well nerves cross over in the medulla, so maybe the blood goes with them? It's called cussation.	Coded to **external exploration** via 'information exchange'; but also to **internal exploration**, via 'hypothesis formation': two categories of CP.

Appendix K: Excerpt from discourse by Group Y1B2; during brainstorming (ii). **CP= cognitive presence; SP= social presence, TP=teaching presence.**			
185	M3	Because … I'm sure he said that on the side of the brain [where] you have a stroke it affects the opposite side of the body	**Integration** category of CP, via linking to experience elsewhere on the 'course'.
186	F3	But that's because it damages nerves	She **facilitates understanding** by 'providing clarification': soft scaffolding TP.
188	M4	No, no, if the blood's not there then it damages the nerves …and it affects the other side of the body	He provides an 'explanation', hence and example of the **internal exploration** category of CP; he simultaneously **facilitates understanding** by 'providing clarification': soft scaffolding TP. Also, because his unifying explanation 'supports' the contributions of M3 and F3, this is also an example of the **cohesion** category of SP.
192	F1	...it's because of the damage the blood clot causes to that part of the brain	She provides an 'explanation', hence and example of the **internal exploration** category of CP.

Appendix K. Excerpt from discourse by Group Y1B2; during brainstorming. *Excerpt of brainstorm by Year 1 PBL Group B2, of utterances relating to the pathophysiology of stroke. The interpretation is given, with the bold font indicating the categories to which the utterances were mapped. This excerpt demonstrates coding of single utterances to categories within different elements (U182 and 188), and to multiple categories within a single element (U184). The excerpt further illustrates that discourse per se facilitates aspects of critical thinking. Moreover, it provides specific examples of teaching presence enabling cognitive presence (soft scaffolding teaching presence in U173 is followed by successive contributions to cognitive presence) and vice versa (since aspects of cognitive presence lead to teaching presence in the form of facilitating understanding).*

Appendix L: Excerpt from discourse by Group Y1B3; during brainstorming (i). **CP= cognitive presence; SP= social presence, TP=teaching presence.**			
U	**By**	**Utterance**	**Interpretation**
161	M4	… *H. influenza* … is that pneumonia or is that flu? It's flu. But it said in [the dictionary] that it was a type of pneumonia.	M4 is *puzzled* (**trigger**). He recalls the dictionary definition from step 1, which causes him to identify *conflicting information* between his existing knowledge – that 'influenza' is a virus which causes the flu - with the *dictionary* entry that *H. influenza* can be a cause of pneumonia. This illustrates interaction between the **resource** category of hard scaffolding TP, the **facilitating understanding** category of soft scaffolding TP, and the **trigger**, **external exploration** and possibly **integration** categories of CP.
162	Fac	So … if somebody came to you with… presenting symptoms which led you to think it was pneumonia, what differential diagnosis would you do to determine what kind of pneumonia it was?	Facilitator probes for more info about causative organisms, linking this to differential diagnosis – another of their learning issues. She **facilitates understanding** by *probing*, and **facilitates the process** by moving them on to talk about differential diagnosis. Interaction between different categories of TP.
163	M2	Is there bacterial and viral or is there just bacterial?	M2 asks a question: **external exploration** category of CP.
164	M4	Can you get viral pneumonia?	M4 asks a question: **external exploration** category of CP.
165	F4	I don't think so.	F4 responds (incorrectly).
166	M1	Would you like take a culture or something like that? Try and find out what organism is actually causing it?	M1 picks up on the Facilitator's *question* and offer an *hypothesis*, which is **internal exploration**; so TP as **facilitating understanding** directly enables CP.

Appendix L: Excerpt from discourse by Group Y1B3; during brainstorming (ii). **CP= cognitive presence; SP= social presence, TP=teaching presence.**			
167	Fac	You would do that eventually.	Facilitator provides soft scaffolding TP in the form of **developmental** *support* by confirming that he is correct, but hints that there is a prior step to be considered
169	Fac	It would take a while for that to get in culture. You probably wouldn't do that unless somebody was admitted to hospital, because you're probably talking about a twenty four hour culture anyway.	The facilitator provides further soft scaffolding teaching presence in the form of **developmental** *support* – possibly providing more information than is strictly necessary.
170	F4	You'd have to ask like what their previous symptoms was, how quickly it was onset. Other symptoms rather than just having a cough, you know what I mean?	F4 *hypothesises* about an appropriate short-term measure: history-taking. She also *exemplifies* this. So she demonstrates the **internal** and **external exploration** categories of CP, which was directly enabled by prior soft scaffolding TP – **developmental** *support* - on the part of the facilitator.
171	M1	Like take a history.	M1 provides *support* for F4's idea, by using the relevant terminology for the measure she suggests. He demonstrates the **cohesion** category of SP.
172	F4	Everyone can have a cough. I've got a cough. I've not got pneumonia.	F4 *applies* the signs and symptoms of the patient in the *scenario* to her own situation and infers that cough is not in itself diagnostic of pneumonia. Interaction between the **resource** category of hard scaffolding TP and **resolution** category of CP.

Appendix L: Excerpt from discourse by Group Y1B3; during brainstorming (iii). **CP= cognitive presence; SP= social presence, TP=teaching presence.**			
173	F2	Like when my uncle got admitted he had … a rash as well? …that's what made them think it was meningitis.	F2 integrates information from *experience* outwith the course. She seems to be providing *support* for F4's idea that a particular combination of symptoms can help arrive at a diagnosis. Thus the **integration** category of CP interacts with the **cohesion** category of SP.
174	F4	That's like, [for] malaria, … different strains have different symptoms. Maybe … different bacteria cause different symptoms in different time periods, incubation, …. Because this is obviously quite a short incubation.	F4 integrates the current learning with her knowledge about malaria (from the previous scenario). She *hypothesises* that pneumonia may have parallels with malaria, in that there may be different causative agents, leading to different signs and symptoms, and with different incubations periods. She finishes by making a reference to the particular case described in the *scenario*. Thus two indicators of the **integration** category of CP interact with the **resource** category of hard scaffolding TP.

Appendix L: Excerpt from discourse by Group Y1B3; during brainstorming. *Excerpt of the brainstorm by Year 1 PBL Group B3, of utterances relating to the aetiology, or causes, of pneumonia. The interpretation is given, with the bold font indicating the categories to which the utterances were mapped; and italicized font indicating the relevant indicators. This excerpt demonstrates directly that teaching presence enables aspects of critical thinking; for example, soft scaffolding interventions by the facilitator (U162) are immediately followed by aspects of critical thinking on the part of several students (U163 to U166). The excerpt also demonstrates the interaction between all three elements, with cognitive, social and teaching presence featuring in the various utterances.*

Appendix M: Examples of interventions by Facilitator of Group Y2C3.			
Category	**Indicator**	**Utterance**	**Text**
Facilitating understanding.	Questioning.	117	[Bile] salts and acids are the same thing?
	Probing.	270	What would cause [the gallbladder] to contract then? [following on from their suggestion that it wasn't sufficiently thick-walled to have a muscular wall].
	Encouraging integration.	321	You came across this earlier in the year?
		560	Where do you recall this from? ... your lecture ...?
	Identifying conflicting information.	233	... people tend to think of rats just being big mice or mice just being little rats, but interestingly mice have gallbladders and rats don't and they survive quite well without [one] ...
Facilitating development.	Providing support.	594	Well in the final stages of people with chronic alcoholism they're quite yellow... [responding to student talking about clinical jaundice].
	Modelling learning.	467	… Until he'd told me this I'd assumed [ultrasound] was just a painless procedure. [modelling not making assumptions, lifelong learning].
	Giving feedback.	283	... That's good retention of previous knowledge.
		343	Maybe look over that. You're on the right tracks.

Appendix M. Examples of interventions by Facilitator of Group Y2C3*. This table illustrates some interventions by the facilitator of the Year 2 PBL Group, Y2C3.*