Improving Education in the Domain of Professional Issues in Software Engineering:
Using Action Research and Collaborative Learning with ICT

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Abstract

This research examines the use of ICT to support a group-based pedagogy in Professional Issues in Software Engineering (PISE). The research was conducted over eight cycles of teaching and uses an action research methodology to investigate different research themes.

The research introduces the concept of multi-institutional collaboration in the teaching and assessment of PISE.

Issues were identified throughout the research phases and these led to the following developments:

- guidelines for learners on using online discussion in an academic setting
- recommendations for institutions intending to collaborate on teaching and assessment
- guidelines on building and sustaining online learning groups
- instrument for formative and summative assessment of learning in online discussions
- design and evaluation of a tool to facilitate data visualisation for learning feedback for students and lecturers

The outcomes from this research indicate that, providing the appropriate preparations are made, a multi-institutional approach to teaching and assessment can enhance student learning in PISE and related subject domains. Furthermore, in a time when there is increased demand for graduates with the skills to deal with globalised work practices, tools to teach such skills at third level are now particularly important. This study goes some way to identifying best practices and the design and use of appropriate tools to support this.
Declaration

I declare that the work presented in this thesis is to the best of my knowledge and belief original and my own work except as otherwise acknowledged in the text. The material has not been submitted, either in whole or in part, for a degree at this or any other university.

Joseph Griffin

Timothy Hall
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Conducting a study spanning eight years requires a lot of support and assistance, without which I would not have completed this thesis.

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To the students who gave me such useful feedback over the years. I also hope that future generations of learners will benefit from the methods developed as a result of your input.

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Table of Contents

1 Introduction.........................................................................................................................1
  1.1 Background to the research.............................................................................................1
  1.2 Research problem.............................................................................................................3
  1.3 A note on writing style.....................................................................................................3
  1.4 Justification for research.................................................................................................5
  1.5 Usefulness of research findings.......................................................................................6
  1.6 Methodology....................................................................................................................7
  1.7 Thesis outline...................................................................................................................9
    1.7.1 Chapter 2 Research issues/literature review.................................................................9
    1.7.2 Chapter 3 Methodology..............................................................................................9
    1.7.3 Chapter 4...................................................................................................................9
    1.7.4 Chapter 5..................................................................................................................10
    1.7.5 Chapter 6..................................................................................................................10
    1.7.6 Chapter 7..................................................................................................................10
    1.7.7 Chapter 8..................................................................................................................11
  1.8 Conclusion.....................................................................................................................11

2 Research issues/literature review......................................................................................12
  2.1 Introduction.....................................................................................................................12
  2.2 Learning in third level education....................................................................................14
    2.2.1 Using ICT to support learning....................................................................................14
  2.3 Learning paradigms..........................................................................................................16
    2.3.1 Defining learning.......................................................................................................16
    2.3.2 Transmissive learning...............................................................................................22
    2.3.3 Behaviourist approach.............................................................................................24
    2.3.4 The cognitivist approach...........................................................................................27
    2.3.5 More recent theories.................................................................................................30
    2.3.6 Towards a constructivist paradigm...........................................................................31
    2.3.7 Constructivism..........................................................................................................35
  2.4 Constructivist learning environments (CLEs)...............................................................42
    2.4.1 Three constructivist learner-centred pedagogies.......................................................45
      2.4.1.1 Problem-based learning.......................................................................................46
      2.4.1.2 Self-directed learning.........................................................................................50
      2.4.1.3 Collaborative learning.......................................................................................52
  2.5 A Design for learning environments..............................................................................55
    2.5.1 Learner centred .........................................................................................................58
    2.5.2 Knowledge centred..................................................................................................59
    2.5.3 Assessment centred..................................................................................................60
    2.5.4 Community centred..................................................................................................60
  2.6 Interaction in online learning..........................................................................................61
    2.6.1 Types of interactions.................................................................................................62
  2.7 Enhancing higher-order critical thinking skills...........................................................64
    2.7.1 Learning outcomes....................................................................................................65
    2.7.2 Links between developing higher-order critical thinking and collaborative learning..........................................................68
    2.7.3 Benefits of ICT-enhanced learning environment.....................................................72
    2.7.4 Online learning communities..................................................................................75
  2.8 Conclusion.....................................................................................................................77
3 Methodology.............................................................................................................................................. 79
  3.1 Introduction............................................................................................................................................. 79
  3.2 Reality and how we perceive it............................................................................................................ 80
    3.2.1 Perspectives and research methods............................................................................................ 82
  3.3 Action Research.................................................................................................................................... 89
    3.3.1 What is action research?.................................................................................................................. 89
    3.3.2 Action research for social change, the link with Habermas and critical theory.......................... 91
    3.3.3 Features of action research ............................................................................................................ 94
    3.3.4 Educational Action Research......................................................................................................... 99
    3.3.5 Action research or just a conscientious teacher?........................................................................... 101
    3.3.6 Action research for educational informatics............................................................................... 104
    3.3.7 Action research for online learning.............................................................................................. 107
    3.3.8 Ethical issues with classroom based action research.................................................................... 108
    3.3.9 Action research in this study.......................................................................................................... 111
  3.4 Qualitative and quantitative methods for data collection and analysis............................................. 112
    3.4.1 Claimsmaking.................................................................................................................................. 112
    3.4.2 Qualitative research....................................................................................................................... 113
    3.4.3 Quantitative approaches................................................................................................................ 116
    3.4.4 Mixed methods................................................................................................................................ 117
  3.5 Conclusion............................................................................................................................................. 121

4 Setting the Scene....................................................................................................................................... 122
  4.1 Introduction........................................................................................................................................... 122
  4.2 Context of the research......................................................................................................................... 122
  4.3 Applying action research...................................................................................................................... 123
  4.4 Initial problems.................................................................................................................................... 124
  4.5 Stakeholder concerns............................................................................................................................ 126
  4.6 Developments on course content in the CSIS degree......................................................................... 127
  4.7 Validation of content and pedagogy in PISE ....................................................................................... 128
  4.8 Developing major research themes for the study.............................................................................. 133
  4.9 Overview of research themes and teaching cycles............................................................................ 133
  4.10 Conclusion.......................................................................................................................................... 135

5 Getting down to work.............................................................................................................................. 137
  5.1 Personal narrative on Cycle 1.............................................................................................................. 137
    5.1.1 Phase 1.1 Selecting the ICT .......................................................................................................... 138
      5.1.1.1 Overview................................................................................................................................... 138
      5.1.1.2 Research Methods and data gathering....................................................................................... 138
      5.1.1.3 Analysis of data and critical reflection...................................................................................... 139
    5.1.2 Phase 1.2 Using ICT to enhance group-based learning – a first attempt.................................. 143
      5.1.2.1 Overview................................................................................................................................... 143
      5.1.2.2 Research method and data gathering....................................................................................... 143
    5.1.3 Phase 1.3 Finding a partner for multi-institutional collaboration.................................................. 149
      5.1.3.1 Overview................................................................................................................................... 149
      5.1.3.2 Research methods and data gathering....................................................................................... 149
      5.1.3.3 Analysis of data and critical reflection...................................................................................... 151
    5.1.4 Phase 1.4 Further use of VLE in PISE: A first multi-institutional collaboration.......................... 154
      5.1.4.1 Overview................................................................................................................................... 154
      5.1.4.2 Research methods and data gathering....................................................................................... 154
      5.1.4.3 Analysis of data and critical reflection...................................................................................... 155
      5.1.4.4 After note to Phase 2............................................................................................................... 163
    5.1.5 Phase 1.5 Second multi-institutional collaboration – collaborating with three institutions....... 163
      5.1.5.1 Overview................................................................................................................................... 163
      5.1.5.2 Research methods and data gathering....................................................................................... 163
7.2 Justification from the literature

7.2.1 Selecting a new VLE 

7.2.2 Developing guidelines

7.2.3 Formative feedback

7.2.4 Assessing individuals in group-based projects

7.2.5 Data visualisation

7.3 Critical reflection on Cycle 3

8 Conclusion

8.1 Introduction

8.2 Online discussions to enhance learning

8.3 Development of a multi-institutional dimension and guidelines to support the use of VLEs in PISE

8.4 Developing guidelines for learners on using academic online discussions

8.5 Methods to build and sustain online learning groups

8.6 Measuring learning and using data visualization to support formative feedback

8.7 Developments in technology

8.8 Future directions

References

Appendix 4_0: Justifying PISE in the CS programme

Appendix 5_0 Scoring Rubric

Appendix 5_1: Blackboard functionality and tools

1.1 Content

1.2 Communication

1.3 Group pages

1.4 Student Tools

1.5 Administration

Appendix 5_2: Course descriptions for first collaborating partners

1.1 Sacred Heart University

1.2 de Montfort University

Appendix 5_3: Pointers For Success In Virtual Group Work

Appendix 6_1: Computing the MJT’s C-score

Appendix 6_2: Guidelines for posting to discussions

Appendix 6_3: MJT questionnaire
# Appendix 7_1: Moodle Functionality

<table>
<thead>
<tr>
<th>Section Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Using Moodle</td>
<td>302</td>
</tr>
<tr>
<td>1.2 Forums</td>
<td>305</td>
</tr>
<tr>
<td>1.3 Other communication tools</td>
<td>309</td>
</tr>
<tr>
<td>1.4 Glossaries</td>
<td>310</td>
</tr>
<tr>
<td>1.5 Administration</td>
<td>311</td>
</tr>
<tr>
<td>1.6 Logs of use</td>
<td>313</td>
</tr>
<tr>
<td>1.7 Rating posts</td>
<td>315</td>
</tr>
</tbody>
</table>

# Appendix 7_2: Invitation To Collaborate

<table>
<thead>
<tr>
<th>Section Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Introduction</td>
<td>317</td>
</tr>
<tr>
<td>1.2 Student cohorts</td>
<td>317</td>
</tr>
<tr>
<td>1.3 Content</td>
<td>318</td>
</tr>
<tr>
<td>1.4 Learning Management System</td>
<td>318</td>
</tr>
<tr>
<td>1.5 Timing issues</td>
<td>319</td>
</tr>
<tr>
<td>1.6 Language issues</td>
<td>320</td>
</tr>
<tr>
<td>1.7 Assessment issues</td>
<td>321</td>
</tr>
<tr>
<td>1.8 Conclusion</td>
<td>322</td>
</tr>
<tr>
<td>1.9 References</td>
<td>322</td>
</tr>
</tbody>
</table>

# Appendix 7_3: Grading Individual Contributions

<table>
<thead>
<tr>
<th>Section Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>324</td>
</tr>
</tbody>
</table>
List of Figures

Figure 1.1 Main research cycles................................................................. 8
Figure 2.1 Relationship between philosophical assumptions and learning environments................................................................. 21
Figure 2.2 Transmissive instruction......................................................... 23
Figure 2.3 Behaviourally supported communication................................. 24
Figure 2.4 Representation of situated, socio-cultural and constructivist processes... 24
Figure 2.5 Overview of constructivism.................................................. 45
Figure 2.6 Overview of the learning theory landscape.............................. 42
Figure 2.7 Relationship between CL, SDL and PBL............................ 46
Figure 2.8 Types of interaction............................................................... 63
Figure 2.9 Bloom’s hierarchical taxonomy of learning............................ 65
Figure 2.10 Bloom’s taxonomy as revised by Anderson and Kratwohl........ 66
Figure 2.11 Bloom’s Affective Domain of Learning Outcomes............... 67
Figure 2.12 Relationship of key learning techniques.............................. 69
Figure 3.1 Overview of philosophical paradigms and their relationship to research methods................................................................. 79
Figure 3.2 Lewin’s spiral of action research.......................................... 94
Figure 3.3 Dick’s simple action research spiral..................................... 96
Figure 3.4 Expansion of the critical review stage of action research........ 97
Figure 3.5 Phases of use of ICT in learning.......................................... 106
Figure 3.6 Designs for linking qualitative research and quantitative research methods ................................................................. 119
Figure 5.1 Phases of Cycle 1................................................................. 137
Figure 5.2 Email sent to LTSN computer ethics list.............................. 152
Figure 5.3 Guidelines for posting in a discussion on Bb......................... 162
Figure 5.4 Guidelines for using bulletin boards.................................... 183
Figure 6.1 Phases in Cycle 2................................................................. 186
Figure 6.2 MJT Calculation matrix for a spreadsheet............................ 191
Figure 6.3 Single (UL only) institution MJT averages............................ 192
Figure 6.4 Multi-institution MJT results.............................................. 192
Figure 6.5 Initial guidelines to students for posting to discussion boards..... 200
Figure 6.6 Aspects of Moral Behaviour................................................ 209
Figure 6.7 Extract from standard MJT.................................................. 211
Figure 6.8 Section of DIT questionnaire.............................................. 213
Figure 6.9 Community of Inquiry model............................................. 214
Figure 7.1 Phases in Cycle 3................................................................. 219
Figure 7.2 Extract from guidelines for posting on Moodle..................... 230
Figure 7.3 Collaboration timetable....................................................... 232
Figure 7.4 First adaptation of the CP framework for categorisation of posts... 234
Figure 7.5 Second enhancement of CP framework................................. 236
Figure 7.6 Discussion thread length.............................................................. 237
Figure 7.7 Moodle output showing grades achieved based on using CP framework to rate posts.................................................................................................................. 240
Figure 7.8 Student view of assessment feedback........................................ 240
Figure 7.9 Usage logs on Moodle.................................................................... 245
Figure 7.10 Lecturer view of graphical output from DVReport...................... 246
Figure 7.11 Student view of quantitative data.................................................. 247
Figure 7.12 Lecturer view of qualitative data output using DVReport............... 248
Figure 7.13 Graphical and numerical output from DVReport........................... 248
Figure 7.14 Student view of qualitative output from DVReport....................... 249
List of tables

Table 2.1 How different epistemological philosophies determine our world view........19
Table 2.2 Pedagogical implications of extreme philosophical viewpoints..................20
Table 2.3 Deeper learning principles.......................................................................23
Table 2.4 Behaviourist ideas for the design of effective learning environments........26
Table 2.5 Cognitve principles of information processing model of learning.............29
Table 2.6 Significant differences between constructivist learning environment and traditional learning environment.................................................................46
Table 3.1 The differences between positivistic and anti-positivistic approaches.....83
Table 3.2 Comparison between different perspectives on the perception of reality and the design of research studies.........................................................85
Table 3.4.1 Summary of Miles & Huberman’s strengths of qualitative research ....116
Table 4.1 Anderson and Krathwohl’s taxonomy as applied to PISE......................130
Table 4.2 Mapping Bloom’s five stage of Affective Domain...................................132
Table 4.3 Chronology of research........................................................................134
Table 5.1 Activity level for multi-institutional online collaboration.......................156
Table 5.2 Functional use of Communication Function........................................157
Table 5.3 Details of usage of Group Pages tools..................................................157
Table 5.4 Thread lengths......................................................................................157
Table 5.5 International group make up.................................................................165
Table 5.6 Breakdown of functional activity on Bb................................................166
Table 5.7 Functional use of Blackboard within the Groups Pages.........................166
Table 5.8 Analysis of thread lengths.....................................................................167
Table 5.9 Production/knowledge construction.....................................................174
Table 5.10 Information sharing/joint construction...............................................175
Table 5.11 Division of labour...............................................................................175
Table 5.12 Production/knowledge construction and Bb functionality....................176
Table 5.13 Information sharing/joint construction and Bb functionality................177
Table 5.14 Division of labour and Bb functionality...............................................177
Table 6.1 Completed MJT forms..........................................................................190
Table 6.2 Breakdown of C-index scores by country.............................................193
Table 6.3 Analysis of postings.............................................................................202
Table 6.4 International groups analysis of postings..............................................205
Table 6.5 Kohlberg’s Six Stages of Moral Judgment.............................................209
Table 6.6 Four Component Model........................................................................212
Table 6.7 Categories for analysis of cognitive presence........................................216
Table 7.2 Production/knowledge construction.....................................................223
Table 7.3 Information sharing/joint construction.................................................224
Table 7.4 Division of labour.................................................................................224
Table 7.5 Allocation of marks for CP categorised posts........................................242
1 Introduction

1.1 Background to the research

In the field of education, Information Communication Technology (ICT), with its web-based resources, has served as a driver of change in the areas of both distance and campus-based learning (Jeffries and Griffin, 2002). Technological developments such as the Internet and tools for browsing have now, for example, made educational collaborations a reality, irrespective of the geographical location of learners. This has happened, in part to accommodate ever larger cohorts of students, while at the same time giving the learner the best possible learning experience.

During the 1990s there was a dramatic increase in the number of student taking computer courses. Over a five year period numbers increased from about 20 to 220 in one particular programme, the BSc. in Computer Systems (Griffin, 2001). One module in this programme, Professional Issues in Software Engineering (PISE), had been established with an emphasis on group-based pedagogies. (PISE is concerned with the legal, ethical and social consequences of the design and use of computer and information systems.) Research, and the experience of my colleagues who originally established the module, supported this approach to teaching, learning and assessment in PISE. In earlier years when this module was delivered with smaller cohorts it was relatively easy to monitor individual progress and to successfully use this group-based approach. However, larger cohorts made this significantly more difficult and raised important management and pedagogical issues including:

- how do you ensure that meaningful learning takes place
- how do you manage to arrange a cohort of 180 students into groups
• how can you allocate topics for assessment, tutorial slots, meeting times without a major impact on the lecturer’s time
• how do you ensure that all students contribute to the assessment tasks
• how do you minimize plagiarism in group-based assessment

One issue that was often raised by external examiners on this programme was how can the lecturer be sure that the grades awarded to individual students are fully deserved, when those students are working in groups? Because assessment is the technique by which we measure any learning that has taken place as a result of educational intervention the methods used to assess learners must be dependable, and this can be problematic in group-based assessment. In other words, how do you ensure that each student in a group is worthy of the grade awarded to that group for the assignment they have submitted? Is a group-based assessment approach educationally valid and verifiable?

These questions led to a consideration of the methods used in the assessment of PISE and the need to develop some process whereby individual contribution could be determined and rewarded. Many lecturers will be familiar with complaints from some students in group-based assessments that not all team members are pulling their weight. This is not an uncommon problem but the difficulties in dealing with it were magnified by the large cohort in PISE.

I as researcher in this study was faced with such problems: large cohorts, a desire to ensure that each student had a meaningful learning experience, and was assessed according to his or her abilities. My academic history of teaching and researching the use of ICT in learning made it a logical step for me to explore using such technology to enhance the learning environment and address these issues.

This research, then, focuses on the use of ICT to underpin group-based learning in one module in the BSc. Computer Systems programme at the University of Limerick (UL), namely Professional Issues in Software Engineering, and to see if this pedagogical approach enhances student learning. However, this raises the fundamental question of how to support student learning in this process.
Just putting students into groups and providing them with the ICT tools is not enough. More is needed in the design of the learning situation so that it is authentic and meaningful for the learner. But this in turn raises further pedagogical and organisational questions.

These issues all contributed to the development of an interest in the use of ICT to enhance a specific learning situation, that of using a group-based approach to teaching large cohorts in the subject domain of PISE. However, it was discovered at an early stage that there was little existing research that could help me with this specific problem. I therefore decided that a series of studies would need to be undertaken in an attempt to answer these research questions. These were eventually carried out over a period of eight academic teaching cycles.

1.2 Research problem
This study focuses on the use of ICT to enhance the learning environment of students studying Professional Issues in Software Engineering as part of the BSc in Computer Systems. The primary research problem can be stated as:

*Can the use of ICT enhance the learning experience of students working collaboratively in the domain of PISE?*

This research question generated further research issues that needed addressing within this study. These were investigated using the action research methodology (see Chapter 3 for more on this) and governed the direction of successive cycles of research. These are described briefly in section 1.7.4 to 1.7.6 below.

Each of these cycles generated further research questions that it was necessary to address to enable the primary research question above to be answered.

1.3 A note on writing style
There has been some debate on how best to report on action research studies. Writing a thesis that is the result of an action research approach causes great problems. The action research methodology is an ‘untidy, evolutionary research process’ (Winter 2007). It is essentially cyclic in nature yet the
thesis is linear in presentation. To accommodate these two, often contradictory, perspectives the thesis adopts two styles.

The usual chapter arrangements are followed for the first three chapters covering the expected content. The style is as would normally be expected in a doctoral thesis. In chapters 5 to 7 where I focus on the research cycles I have adopted a more unusual approach.

Each chapter is structured in the same manner and focusses on one cycle of the research as shown in Figure 1.1 below. These chapters have an initial section which is a personal narrative where I tell the story of the research. There follows a contexted research review which focusses on the justification from the research literature to the areas covered in the cycle. It is thus possible for the reader to just follow the developing story in the personal narrative sections to get a feel for the unfolding aspect of the action research methodology without being interrupted by the associated research. However, if the reader wishes to read each cycle as a stand alone then the personal narrative can be read in conjunction with the contexted research that follows this. Thus the reader can determine which route to take through these three chapters in order to gain the best sensemaking (Knight 2002, as discussed in Chapter 3) from this study.

In these chapters I have also used a narrative mode of writing (Bruner, 1986, Carter, 1993, Clandinin and Connelly, 1993) so that I can include an account of my personal experiences as an educational researcher and lecturer and those of my students, while trying to adopt a constructivist pedagogy in this domain. This writing style is also compatible with both the interpretive nature of the research paradigm that I draw upon (see Chapter 2 for more on this) and the constructivist perspective of the paper that advocates critical self-reflection as a central perspective of educational reform and improved pedagogical methods. According to Bruner (1986) ‘narratives can help us understand reasons for our actions which are motivated by beliefs, desires, theories and values’ and can help the researcher to re-assess understanding of the research domain or problem.
Winter (1996) cited in Davis (2007) argues that action research reports need an alternative way of writing because this research methodology is one in which the nature of the inquiry is constantly changing, each cycle or phase generating only provisional outcomes. In this study, the thesis is only a current snapshot of the results but with further cycles to come. Winter (ibid) has also suggested that the report should be more a collage than a description and the approach should be pluralistic.

Others (Denzin and Lincoln, 2000, Lincoln and Guba, 2000) consider the action researcher more as a ‘bricoleur’, a maker of montages, who uses a wide range of interpretive/qualitative perspectives and reports the research using a narrative that ‘expands the range of understanding, voice and … variations in human experience’. As will be seen in Chapter 3 on Methodologies, the action research approach taken in this study naturally leads to the consideration of alternative methods of reporting.

Finally, it is worth noting that the philosophical perspective of reality underpinning the design of research studies, which is also my own philosophical perspective, is opposed to the positivist view (see Chapter 3 for more on this). One feature of this perspective and how it impinges on research methods is the manner in which research outcomes are reported. Knight (2002) considers that there is a ‘crisis of presentation’ and a need to find alternative ways of presenting ‘overlapping, fragmentary or contradictory experiences’ with the extreme anti-positivist view. He proposes a middle way in research methodology, what he calls critical realism and pragmatism. This perspective allows for the production of reports that are ‘more flexible, use lay language’ and where ‘human language is permissible’ and that do not have to be ‘bound to one reporting format’ (Knight, ibid).

So, in the chapters on the research cycles in this study the style of reportage, or ‘portrayal’ as Lincoln (1997) prefers to call the process, allows this thesis to provide the reader with a narrative that I hope gives a deeper understanding, or as Knight (ibid) calls it ‘sensemaking’, of the research, than a traditional report writing approach would.
1.4 Justification for research

There has been a tradition of research into the use of ICT in teaching and learning ever since computers first became available for use in educational settings. At the same time a new paradigm of learning informed new ways of teaching and assessing. The constructivism paradigm (see Chapter 2 for more on this) led to a growth in research into collaborative and group-based learning. Some research identified the benefits of pedagogies based on this paradigm in some subject domains and in some levels of education. However, my own detailed review of the literature identified that in the domain of PISE no work had taken place. This could be because the area of PISE, and especially the sub-area of computer ethics, is a new field and has only recently been taught in universities (Johnson, 2001).

Although reviews of the research literature showed many types of studies on the use of debate and groupwork to help with ethical reasoning development in medicine and business studies, there was no work being conducted in the domain of computer science. Furthermore, although the adoption of a multi-institutional approach to collaboration in teaching and learning was reported in the literature, at the start of this research I could not find a single study that also included assessment techniques in this approach. So, the combination of the use of ICT to support the constructivist approach to teaching and learning and the idea of multi-institutional collaboration in the domain of PISE, along with the added focus of an assessment component, created a new research area with its own unique research problems.

1.5 Usefulness of research findings

The research findings of this study will be useful not only for this particular domain, but also for other subject areas. Computer ethics is a discursive subject, and in other subject areas where debate and discussion are used as part of the teaching and learning pedagogy the findings from this study may be beneficial.
There is an ever-growing increase in the availability of ICT and familiarity among learners with technology. The growth in the use of Web 2.0 technologies to support social-constructivist learning may benefit from the formal guidelines for learners and teachers produced in this study. The research phases show the types of problems that can arise and provide solutions. This in turn can inform teachers in other areas how best to make use of ICT to enhance collaborative learning in geographically dispersed groups.

1.6 Methodology
Action research has the feature of allowing a research problem to unfold as different aspects are uncovered. It is also a research methodology where a study can take place in the learning environment without any learners being disadvantaged by, for example, being in a control group where they could be denied access to a learning-enhancing development. The rationale behind action research is discussed more fully in Chapter 3. What is worth noting at this stage is how the research developed through several iterations focussed on emerging research question. Figure 1.1 below shows an overview of the main research cycles.
Figure 1.1 Main research cycles
1.7 Thesis outline

The follow sections give an outline of the structure of the remaining chapters of the thesis.

Chapters 5, 6 and 7 focus on the action research cycles and have a similar format, i.e. in the first part the phases of the research cycle are described. This is followed by a literature review and discussion of issues related specifically to the research being undertaken. The chapters conclude with a critical reflection on the research cycle. My intention was that this would make the thesis more readable.

1.7.1 Chapter 2 Research issues/literature review

This chapter looks at theories of learning and learning paradigms, the theoretical basis for online learning and collaborative learning approaches. One aim of this chapter is to show the link between approaches to teaching and learning and the development of critical thinking skills in learners. Finally the chapter examines the features of the computer ICT-based tools that can be used in this process. As mentioned above, the literature review specific to each research cycle is contained in later chapters along with the discussion of the research conducted.

1.7.2 Chapter 3 Methodology

In this chapter the research methodology adopted in this study, action research, is discussed. As in the previous chapter, the discussion begins with a brief look at the philosophical debates underpinning approaches to research. The action research approach is then considered and its appropriateness for educational research discussed. Finally, a consideration of approaches to the collection and analysis of date are examined, particularly qualitative and quantitative research methods and mixed methods approaches.

1.7.3 Chapter 4

In this chapter I focus on the background to the study. I explain the organisational and other contexts that led to specific professional practice issues that I encountered when I first became a faculty member at UL. How I dealt with the conflict in maintaining a group-based approach in
teaching and assessment in PISE is outlined. I also discuss how I had to consider the sometimes, contradictory requirements of different stakeholders.

This was an early ‘fuzzy’ stage in the cycle of action research as Dick (2002) describes it. It enabled me to develop a specific research question which was addressed over the following three cycles.

1.7.4 Chapter 5
This chapter focuses on Cycle 1 of the action research. It is in this chapter that I discuss the selection and use of ICT to support group-based learning in PISE. Problems from the first use of this with the UL cohort of students led to the development of a multi-institutional approach. This involved the identification of suitable collaboration partners and further cycles of teaching and research with these partner institutions. Problems and solutions to this teaching method are discussed.

1.7.5 Chapter 6
Determining the effectiveness of educational intervention and teaching strategies can be difficult. In this chapter I discuss different methods I adapted to determine the success, or otherwise, of the ICT-supported multi-institutional approach I was developing. I also discuss the link between moral reasoning development and its relationship to the attainment of higher-order critical thinking skills by learners.

1.7.6 Chapter 7
In this chapter I discuss the selection and adoption of an alternative virtual learning environment called Moodle, which was designed from a constructivist perspective. The phases of the research cycle then focus on the development of a formative feedback and individual assessment mechanism. The chapter continues with a discussion of the development of a tool to enable learners and lectures to see a graphical representation of student online behaviour.
1.7.7 Chapter 8
This is the concluding chapter where I draw together the research outcomes and suggest possible future research directions.

1.8 Conclusion
This chapter has introduced the area of study of this thesis. It has given a brief historical overview of the reasons that led to this research being undertaken. The primary research question has been stated and further research questions that have been investigated through the action research cycles have been stated. The following chapters will provide more detailed discussions on these issues.
2 Research issues/literature review

2.1 Introduction
In this chapter a number of different theoretical approaches are considered to investigate the primary research question:

Can the use of ICT enhance the learning experience of students working collaboratively in the domain of PISE?

This study concerns the design, development and implementation of an ICT enhanced pedagogical method for teaching and learning in PISE. However, before this primary research question can be answered a number of concepts need to be investigated.

For example:

• What do we mean by learning?
• Are there specific types of learning in higher education and particularly in this domain, PISE, that might be more effective than others?
• How do different types of learning theory influence the design and use of ICT in this learning environment?
• How can ICT be used to help establish and maintain learning groups?
• How can we measure the learning effectiveness of ICT and can learner attainment tell us anything about its use in enhancing the learning process?

The debates surrounding the theoretical and pedagogical issues in the teaching and learning process have raged for a number of decades now, and they show no sign of being resolved. If anything, the debate is gaining renewed impetus, especially as government funding, and in some cases legislation, focus on effective learning environments. A recent paper by Kirchner et al (2006) sub-titled ‘An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching’, and the refutations published in response, give an indication of some of the current disagreements on the use of specific learning paradigms in the design of learning environments.
This chapter starts by examining the aim of learning in the university, or third level sector as it is called in Ireland, and looks at some of the types of learning approaches that are used.

The discussion continues by considering the development of philosophical concepts on the nature of reality, the nature of the mind and the nature of knowledge. Debates on these concepts have influenced the development of learning theories such as behaviourism, cognitive models and constructivism. Particular attention is paid to constructivism and how this had an impact on the current study.

The differing learning theories that constitute the history of this area have influenced the development of a wide range of learning principles. For example, at the simplest level there is the discordance between teacher-centred and student-centred pedagogies. The implications for the way knowledge is gained by the learner are at the root of a variety of learning environment designs and also hark back to the philosophical conceptions that the protagonists of each ‘school’ follow.

How ICT can contribute to the design of learning environments is discussed through a review of the theoretical basis for online learning approaches. However, as will be seen, online learning is only a method and there is more to this approach than simply the application of technology. The selection and use of appropriate ICT to enhance learning environments, especially those that implement the constructivist pedagogical perspective, are discussed. This has consequences for the establishment and sustaining of online learning groups, and issues to do with this are then investigated.

There are further theoretical discussions that need to be undertaken in relation to different cycles of research that constitute this study. It would be overwhelming for the reader to have to absorb all of these at this early stage. Therefore they will be reviewed in the context of the particular cycle or phase for which they form a research context. The rationale for this approach is more fully discussed in the next chapter.
2.2 Learning in third level education
Many attempts have been made to define what is academic learning at third level, and although there are variations, there is general agreement that academic learning in this context is the acquisition of high-level knowledge by undertaking a range of activities. But what is meant by terms such as high-level knowledge, and how does this happen as a result of learning? And what types of activities will promote this process?

In this section theories of learning will be examined so that third level learning can be put in historical and theoretical context. A case for the constructivist paradigm will be developed and how this can define the pedagogical approach to the learning environment will be examined. Finally, arguments in support of a problem-solving outcome-based pedagogy will be put forward, with support to show how computer-mediated asynchronous computer conferencing can enhance the learning outcomes of this approach.

The development of critical thinking skills in learners is one of the main objectives of university level education. One reason for teaching computer ethics, this researcher argues, is that it is a way in which critical thinking can be developed. But there is a perennial question of how to measure whether the pedagogical methods adopted contribute to this development. It has been argued (Sotto, 1996) that what constitutes 'good teaching' in higher education is not well understood, and how it relates to students' learning is a complex issue.

2.2.1 Using ICT to support learning
The primary focus in this research is on computer-supported collaborative learning. This is operationalised by the use of virtual learning environments (VLE). Among the functional tools in these systems are online discussion forums, whiteboards, wikis, blogs, chatrooms, incorporation of learning materials and facilities to link to other e-resources. A feature of VLE is the ability to facilitate computer-mediated communication via online discussion boards, and this aspect has been of central interest in this study.
However, a number of fundamental questions need to be asked when considering research into the use of computer-mediated communication in online learning environments. Some of these questions concern the type of learning that it is expected will take place, and the answers influence the design of such learning environments. Nunes (1999) has identified three questions that the researcher needs to ask before embarking on the introduction of ICT to the learning environment:

- Why is the environment being developed?
- What is the focus of the environment?
- Who are the learners?

In this study the environment was being developed in response to a pragmatic need. As will be seen later (Chapter 4), an increase in the cohort from about 30 students to over 120, and with further increases expected in subsequent years, some changes needed to be made to ensure no degradation of the learning experience.

The focus of the learning environment was a final year undergraduate module in the computer systems degree programme. The module, Professional Issues in Software Engineering (PISE), is described later. One factor that can be noted here is that the existing constructivist pedagogic method of problem- and group-based learning and assessment had already been determined to be an effective method in this type of course, with numerous supporting studies from the literature. The essential problem was one of scaling up to the much larger cohorts without the potential damage to the teaching and learning process that can occur is such situations.

The learners in this situation were computer systems undergraduates. They had a typical natural science secondary level educational and would have had to be high achievers in maths at leaving certificate to gain entry to this degree programme. They would have had limited experience in an academic subject that was essentially discursive in nature, so would need scaffolding and support in this learning process.
The aim of learning in this context was to develop ethical problem solving and moral reasoning with students who had come from a pedagogic tradition that could be described as *objectivist*. This is discussed in detail below. However, a *constructivist* pedagogy methodology was already adopted in PISE. (Note: learning paradigms and pedagogies are further discussed in following sections of this chapter.) Added to this was the intention of introducing an ICT component into the teaching and learning situation as it was felt that this could enhance the learning experience for larger cohorts while maintaining the existing pedagogy.

### 2.3 Learning paradigms

Traditional teaching and learning approaches have been criticised for failing to support higher-order thinking and problem solving and creating compliant and superficial learning (McCaslin et al, 1992, Spiro et al, 1991). The constructivist approach (see below) has also been the subject of much criticism for promoting learning paradigms that are unproven, not based on substantive theory and impractical to implement (Dick, 1991, Merrill, 1991). However, there are also many educational researchers who argue that constructivist pedagogies are more likely to effect the attainment of higher-order critical thinking skills than traditional transmissive type pedagogies. The many different perspectives to learning have their bases in psychological theory development over the past three or four decades. In this section these will be examined, and their impact on the design of learning and teaching environments considered.

#### 2.3.1 Defining learning

There are many, many definitions of learning throughout the literature. However, a commonality among them is that learning results in permanent changes in our knowledge or behaviour as a result of some activity or experience. The three features of these types of categorizations of learning are:

- learning occurs when there is change in behaviour or knowledge
- some activity or experience causes this change
- the change is permanent
Following on from the first point above, there is a need to decide what is meant by knowledge and where this knowledge resides. So we need to be able to answer such questions such does knowledge reside in the individual head/mind, between individuals or does it exist as part of behaviour? Answers to these questions have been at the heart of the development of learning theories such as behaviourism, cognitivism and constructivism. These in turn have had an impact on ideas about what types of learning environments are appropriate to the learning process.

The second feature of the definition of learning above refers to the presence of an experience or activity in this process of change. In relation to third level education there are many types of activities and experiences such as practice, repetition, application of knowledge, discussion and collaboration. We could also include passive behaviours such as sitting in lectures. And what about informal activities such as talking and discussing with peers outside of the formal learning environment? Sfard (1998) asks a further fundamental question: ‘does learning require the transmission of knowledge, active participation in the learning process or some combination of both of these?’ Answers to this type of question underpin the pedagogical approach adopted in the classroom and contribute to the discussion on the third feature of learning as outlined above.

The third point above states that for something to be defined as learning the change in behaviour or knowledge must be permanent. As Concannon (2006) points out, this introduces us to the problem of defining the nature of the mind, how it is structured and its stability over time. Although it is outside the scope of this thesis to discuss this topic in detail, it is worthwhile briefly considering the philosophical debates on this, and their influence on theories of learning.

Concannon (2006) points out that historically there have been three main philosophical perspectives on the nature of the mind, reality and knowledge. These are known as Cartesian Dualism, Materialist Monism and Ontological Pluralism.

The Cartesians argued for a concept that considered the mind as separate from the body and subject to its own laws of reason and logic. It was disconnected from reality. The Materialist view argued
that external stimuli were perceived directly by the mind and that therefore there was no such thing as internal representation of the world such as thoughts and feelings. So the mind was a passive recipient of perception. Finally the Pluralists argued against this last position by adopting a realist or empiricist approach. Immanuel Kant, who is most associated with this approach, argued that the human mind is an active originator of experiences and not just a passive recipient of perception. Each one of these three very different conceptions of the nature of the mind have had a profound effect on pedagogies.

Cronje (2006) has summarised the extremes of the philosophical positions as they relate to the objectivist and constructivist pedagogies. Table 2.1 below relates the concepts of reality, how symbols and language are used, the nature of the mind and thought and definitions of meaning to these two extremes.
The real world… has artifacts that can be categorized on the basis of their properties and relations.

Reality is… entirely and overtly structured in a mutual way by all who perceive it. Reality can be represented and shared with others.

Symbols and language are… only meaningful to the degree that they correspond to the reality that they represent.

The human mind… represents nature by processing abstract symbols.

Human thought is … independent of cognitive processes and is primarily symbol manipulations.

Meaning… is external to the us i.e. exists objectively and independently of our minds.

is constructed by our individual minds based on our interactions.

is personally constructed in a universe of multiple realities. Our model of reality is constructed by us personally.

cultural products that are used to create reality.

perceives and understands the world by creating symbols.

imaginative. It develops form perception, our sensory experiences and our social interaction.

depends on our experience and understanding when it is constructed.

Table 2.1 How different epistemological philosophies determine our world view.

Even accepting that these are extreme viewpoints it can be seen that the implications of a particular philosophical perspective result in very different interpretations of our world.

Cronje also argues that these extreme positions have implications for teaching pedagogies. In a review of the literature he summarised these. Table 2.2 below is based on his summary.
Table 2.2 Pedagogical implications of extreme philosophical viewpoints.

<table>
<thead>
<tr>
<th>Category</th>
<th>Extremes on continuum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epistemology</td>
<td>Objectivism</td>
</tr>
<tr>
<td>Pedagogical philosophy</td>
<td>Instructivist</td>
</tr>
<tr>
<td>Underlying psychology</td>
<td>Behavioural</td>
</tr>
<tr>
<td>Instructional sequencing</td>
<td>Reductionist</td>
</tr>
<tr>
<td>Goal orientation</td>
<td>Sharply focused</td>
</tr>
<tr>
<td>Role of teacher-instructor</td>
<td>Authoritarian-Didactic</td>
</tr>
<tr>
<td>Experiential value</td>
<td>Abstract</td>
</tr>
<tr>
<td>Programme flexibility</td>
<td>Teacher-proof</td>
</tr>
<tr>
<td>Value of errors</td>
<td>Errorless learning</td>
</tr>
<tr>
<td>Motivation</td>
<td>Extrinsic</td>
</tr>
<tr>
<td>Structure</td>
<td>High</td>
</tr>
<tr>
<td>Learner control</td>
<td>Nonexistent</td>
</tr>
<tr>
<td>Accommodation of individual differences</td>
<td>Nonexistent</td>
</tr>
<tr>
<td>Cooperative learning</td>
<td>Unsupported</td>
</tr>
<tr>
<td>Cultural sensitivity</td>
<td>Minimal</td>
</tr>
</tbody>
</table>

Although we are still in the early stages of defining what learning is, it can be seen that philosophical perspectives have profound effects on this definition and how it is realised in learning contexts. The nature of pedagogies is discussed further in the following sections.
Figure 2.1 above shows the relationship between philosophical assumptions and learning environments. As has already been seen, philosophical assumptions have influenced the development of the major learning theories. These theories have in turn been used to posit a range of learning principles. For example, Carmean and Haefner (2002) proposed a set of ‘deeper learning principles’ as shown in table 2.3 below.

These learning principles, in turn, have been used in the design of learning environments.
<table>
<thead>
<tr>
<th>Learning is....</th>
<th>When...</th>
</tr>
</thead>
</table>
| Social         | It involves cognitive apprenticeships.  
|                | It promotes reciprocity and cooperation among students.  
|                | It offers prompt feedback.  
|                | It encourages contact between students and faculty.  
|                | It emphasizes rich, timely feedback.  
| Active         | It is engaged in solving real-world problems.  
|                | It is intertwined in judgment and exploration.  
|                | It is situated in action.  
|                | It uses active learning techniques.  
|                | Practice and reinforcement are emphasized.  
|                | Involvement in real-world tasks is emphasized.  
| Contextual     | New knowledge builds on the learner’s existing knowledge.  
|                | New knowledge is integrated into the learner’s world.  
|                | Knowledge is applied by the learner.  
|                | New knowledge is demonstrated to the learner.  
|                | Students have a deep foundation of factual knowledge.  
|                | There is awareness that students come to the classroom with  
|                | preconceptions about how the world works.  
|                | Students understand facts and ideas in the context of a  
|                | conceptual framework.  
|                | Learning is concrete rather than abstract.  
| Engaging       | It respects diverse talents and ways of learning.  
|                | It communicates high expectations.  
|                | It is done in high-challenge, low-threat environments.  
|                | It emphasizes intrinsic motivation and natural curiosities.  
| Student-centered | Students organize knowledge in ways that facilitate retrieval and  
|                | application.  
|                | Students take control of their own learning: noting failures,  
|                | planning ahead, apportioning time and memory to tasks.  
|                | It emphasizes time on task.  
|                | It emphasizes learning independence and choice.  
|                | It allows time for reflection.  
|                | It emphasizes higher-order thinking (synthesis and reflection).  

Table 2.3 Deeper learning principles from (Carmean and Haefner (2002) )

In the next sections the focus will be on some of the major learning theories and their impact on teaching and learning environments.

### 2.3.2 Transmissive learning

The roles of the teacher and learner are determined by the pedagogical methods used in the classroom. These have changed radically over the years. Early research into approaches to learning focused on the method of transmitting knowledge from one source to the learner. This form of traditional instruction is often referred to as *transmissive* instruction (Jonassen et al, 2000), where
knowledge is transmitted from teachers (or technologies) to learners’. Figure 2.2 below summarises this approach.

With this model it was believed that learning would be enhanced by improving the clarity of messages between the teacher and the student. So if teachers transmitted all they knew effectively to the learner, then the learner would eventually ‘know’ what the teacher knew. The teaching process was about the effective communication of concepts from teacher to learner.

Inherent in this approach was the idea that the teacher knew more because he/she had studied the subject matter longer than the learner. So epistemologically this also assumed that knowledge is an object that can be conveyed from one to another. It also assumed that the learner was uncritical of the knowledge that the teacher held and unquestioning of its validity.

A development of this idea included a feedback loop to amplify the communication process. This feedback loop was achieved by allowing the learner to practice what had been transmitted. Fig 2.3 below illustrates this.
However the basic theory underpinning this model remained the same, objectivist theory of learning that it is still widely practiced today in the traditional lecture in many third level institutions with the lecturer talking to (or even at) a passive audience of students.

### 2.3.3 Behaviourist approach

Transmissive pedagogical methods are primarily teacher-centred. Behaviourism was an attempt to move from the teacher-centred approach and to put the learner in control of the learning. It is also worth noting at this point that behaviourism was once a reforming movement in educational theory with a core commitment to active learning. Those who supported the concepts of programmed instruction aimed to make the teaching process more individually tailored and effective. A full range of media and technology were used in the design of new methods of instruction. According to Wilson (2000), it was the reform of a teacher-centred classroom and lectures that behaviourists were trying to achieve.

Behaviourism became, and in some cases still is, one of the most influential theories of learning to affect the way teachers approached the learning environment. The behaviourist school of Thorndike (1913), Pavlov (1927) and Skinner (1974) postulates that learning is a change in observable behavior caused by external stimuli in the environment. This theory proposed that human behaviour is a result of responses to external stimuli. The adapting of this theory to the learning environment resulted in the teaching technique known as programmed instruction.
In this pedagogical method the learner is presented with discrete pieces of learning and has to demonstrate that the piece of learning has been understood before being presented with the next piece.

The behaviourist approach to learning became the dominant theory of learning throughout most of the 20th century. It was based on the *objectivist* philosophy, which proposed that reality is external to the individual. And knowledge expresses this reality. Therefore for the learner to understand the world it is only necessary to transfer this knowledge from a reliable source to that learner. Such reliable sources were usually a textbook or an expert/teacher. For behaviourists learning was primarily about the acquisition and strengthening of responses to the reception of new knowledge.

Some of the key points of behaviourism as applied to designing learning environments are summarised in Table 2.4 below.
<table>
<thead>
<tr>
<th>Behaviourist idea</th>
<th>Application and explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learn by doing</td>
<td>Learning is best achieved by an active engagement of tasks.</td>
</tr>
<tr>
<td>Taxonomies</td>
<td>Type and complexity of learning outcomes can be differentiated, leading to classification schemes called learning taxonomies which guide instructional design.</td>
</tr>
<tr>
<td>Conditions of learning</td>
<td>Conditions that lead to effective learning can be identified leading to effective learning.</td>
</tr>
<tr>
<td>Behavioural objectives</td>
<td>Instruction should be based on clear behaviourally specified objectives linking these to assessment tasks.</td>
</tr>
<tr>
<td>Focus on results</td>
<td>Measurable behaviours are the best guide to gauge instructional effectiveness and hold teachers and schools to account.</td>
</tr>
<tr>
<td>Alignment</td>
<td>Consistency or alignment between learning objectives, instructional and assessment strategies is a feature of good instruction.</td>
</tr>
<tr>
<td>Task decomposition</td>
<td>Learning is more effective when complex problems are broken down into more manageable tasks which are mastered separately.</td>
</tr>
<tr>
<td>Prerequisites</td>
<td>Certain large tasks need to have sub-tasks learned first. Students learn the large tasks more easily if they have first learned the sub-tasks.</td>
</tr>
<tr>
<td>Small successes</td>
<td>Sub-tasks allow the learner to achieve small successes which are reinforcing and generate motivation.</td>
</tr>
<tr>
<td>Response sensitive feedback</td>
<td>Students learn best when they know how correct they have been. Feedback should be given to let the learner know where they were wrong and how to improve.</td>
</tr>
<tr>
<td>Science of instruction</td>
<td>Teachers need to be precise and systematic about their thinking, teaching and student evaluation. This is only possible with a science of instruction ontology.</td>
</tr>
<tr>
<td>Performance support</td>
<td>‘On-the job’, ‘just-in-time’ training works best in the workplace. More effective training occurs closer to the job or workplace.</td>
</tr>
<tr>
<td>Direct instruction</td>
<td>Clear directions, presentations that are well prepared, suitable examples and opportunities for practice will result in enhanced student learning.</td>
</tr>
<tr>
<td>Pre-testing, diagnostics</td>
<td>Prior skills, motivation and other important factors should be used to determine which of a range of instructional strategies a learner follows.</td>
</tr>
<tr>
<td>Transfer</td>
<td>Learners need to practice in order to be able to transfer a skill from one task to another.</td>
</tr>
</tbody>
</table>

Table 2.4 Behaviourist ideas for the design of effective learning environments.

Looking at Table 2.4 above there are certainly a number of points which most educators today would have little or no problem adopting. And, of course, many teachers would subscribe totally to this list.
Behaviourism sought to explain learning in terms of observable behaviour with little emphasis on, or reference to, mental events and entities, the so called ‘black box’ approach. It was this avoidance of mind and meaning that was eventually challenged by the development of cognitive psychology.

2.3.4 The cognitivist approach

Cognitive psychology emerged in the 1960s as a response to the behaviourist paradigm. While not disproving the behaviourist thesis, the cognitive approach attempted to explain the mental processes that were occurring in the behaviourists’ black box. One of the early proponents of the cognitive approach was Noam Chomsky (1959), who argued that language was not acquired purely through conditioning but must in part be explained by the existence of some internal mental states which were common to all humans.

One of the main features of the cognitivist approach has been the focus on the individual. An essential feature of this paradigm is that knowledge exists in, and is processed by, an individual’s mind. The focus of cognitive research has been on memory and the representation of knowledge.

Cognitive psychology claims that learning involves the use of memory, motivation and thinking, and that reflection plays an important part in learning. Supporters of this perspective see learning as an internal process, and contend that the amount learned depends on the processing capacity of the learner, the amount of effort expended during the learning process, the depth of the processing (Craik and Lockhart, 1972; Craik and Tulving, 1975) and the learner’s existing knowledge structures (Ausubel, 1974).

At the same time as the cognitivist paradigm emerged computer technology was also developing, resulting in the very influential metaphor for cognitive psychology from the world of computer science: information processing theory (Bruner 1983). This caused cognitive psychology to move from a focus on the construction of meaning to one of processing information.
Cognitivist researchers used a number of experimental situations such as measuring reaction times, eye movement studies and ‘think aloud’ protocols to suggest computational models of the mind and how information was processed. This was based on the dualist philosophical perspective with a ‘world out there’ and a representation of that world in the mind. Research into the type of mental structures that represented the outside world became the overriding focus of effort.

For the designers of learning environments, mapping the cognitive structures of experts into learners’ minds, and determining how similar these structures were between expert and novice, was a measure of the success of the learning environment. Table 2.5 below gives an overview of the cognitivist, information processing approach to the design of learning environments.
<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stages of processing</td>
<td>Input is processed sequentially from sensory information in perceptual memory which passes to working and then long-term memory. This then generates a response.</td>
</tr>
<tr>
<td>Task modeling</td>
<td>Use of flowcharts to model tasks, called cognitive task analysis. This can help identify learning errors and make learning systems better targeted.</td>
</tr>
<tr>
<td>Attention</td>
<td>Correct level of novelty in learning environment can generate learner attention, too much or too little novelty can lead to boredom or anxiety.</td>
</tr>
<tr>
<td>Selective perception</td>
<td>Perceptions are affected by goals, understandings or expectations.</td>
</tr>
<tr>
<td>Memory load</td>
<td>Working memory is able to hold five to seven chunks of information, so this can be used to design learning environment to reduce memory load.</td>
</tr>
<tr>
<td>Knowledge types</td>
<td>Two types: Declarative – which is knowing <em>that</em>; propositions in semantic networks. Procedural – which is knowing <em>how</em>; IF-THEN rules, pattern recognition</td>
</tr>
<tr>
<td>Skill compilation</td>
<td>Repeated practice leads to skill becoming compiled combining several steps into one routine. Automaticity occurs when two tasks can be processed simultaneously without problems.</td>
</tr>
<tr>
<td>Encoding of information</td>
<td>How information is stored in long-term memory for easy retrieval. Chunking, elaboration are two suggested ways.</td>
</tr>
<tr>
<td>Metacognition</td>
<td>Self-monitoring, self-regulation and knowing when and where to use problem-solving strategies and knowledge.</td>
</tr>
<tr>
<td>Motivation</td>
<td>Intrinsic and extrinsic are most commonly known. But also incentives, self-efficacy, success-failure attributes. All cited as what makes people do things, learners learn tasks.</td>
</tr>
<tr>
<td>Experts &amp; novices</td>
<td>Domain specific knowledge, refined domain specific routines, periods of reflection are all characteristics of expert.</td>
</tr>
<tr>
<td>Human development</td>
<td>Changes in stages from concrete to abstract reasoning or from fixed authoritarian views of knowledge to acknowledgment of interpretation and perspective. Instruction needs to be matched to development stage.</td>
</tr>
<tr>
<td>Conceptual change</td>
<td>Schemas or mental models are used to make sense of the world. Mismatch between schema and experience leads to further enquiry and reflection to resolve this conflict. Learning helps to assimilate new information into existing schemas or cognitive structures.</td>
</tr>
</tbody>
</table>

Table 2.5 Cognitive principles of information processing model of learning.

Although the information processing or computational model provides a view of the mind, it is a particular model of the mind. In this model information is processed sequentially according to a set
of rules. Humans (and computers) input information or data and reflect on this or process it. This thinking or reflecting ‘goes on subconsciously, mediating every behaviour’ (Clancey 1993). But as Wilson (2000) points out, this has raised a number of issues. For example:

- do we really think about all of our actions?
- are we following rules or have rules been applied after the fact to try and explain our behaviour?

This stress on rule-based models and explicit memory structures is very constraining and is also very dualistic. The focus of symbolic cognition is centred on the individual and ignores any cultural or even physical context. The question of how individual cognition fits with others' language and culture is ignored. This has lead to the argument that tools, people, language and culture are major contributors in the construction of meaning.

2.3.5 More recent theories

Over the past two decades or so there has been a convergence of learning theories moving away from these earlier objectivist-based theories. These developments, Jonassen et al (2000) state, have been ‘the most substantive and revolutionary changes in learning theory’. What makes this revolution so radical is the change in the underlying ontology, epistemology and phenomenology of learning.

Situated, socio-cultural and constructivist theories of learning now share many assumptions and promote similar approaches to the design and use of computers in the learning environment. Among these assumptions are the beliefs that learning is not a transmissive or submissive process, but willful, active, intentional, conscious and constructive behaviour that must also include reciprocal – intention – reflective practice as illustrated in Figure 2.4 below.
Furthermore there is recent evidence from the literature that suggests that group and social factors influence learning development (Pascarella and Terenzini, 2005). In other words, that individuals do not exist in isolation. Vygotsky (1978) has also argued that we cannot think of ourselves as developing cognitively in isolation, that cognition is not individualistic. Situated learning theorists such as Lave and Wenger (1988) have also argued against the individualistic approach, asserting that knowledge does not exist in the individual’s head but is ‘stretched over, not divided among mind, body, activity and culturally organised settings’

As a critical reaction to earlier paradigms these approaches promote the idea that the individual does not exist in isolation, knowledge is not an object that simply exists in an individual’s head, that knowledge is not transmitted from a source to the learner, and that learning is to do with meaning making. Such changes affect ideas about how we learn and also affect the design and use of artifacts, such as ICT-supported learning environments, that can enhance the learning process.

**2.3.6 Towards a constructivist paradigm**

As a reaction against the traditional didactic approach to learning, constructivist approaches have become more dominant. A review of the literature shows that recent developments in the history of learning theory assert:
Learning is a process of meaning making where humans interact with other humans and the world in an attempt to make meaning from those interactions – no longer is it considered to be just a process of knowledge transmission.

Learning is a social process as opposed to ideas in older theories which focused on the individual and the cognitive processes of that individual. The social constructivists believe that meaning is made (and learning takes place) by social negotiation of the participants and learning is 'inherently a social dialogue process'.

Learning is distributed and takes place in 'communities of practice' (Lave and Wenger, 1991), and as the learner interacts with these communities their knowledge and beliefs are influenced by the communities and vice versa.

So knowledge exists not just in our individual and socially negotiating minds, but ‘also exists in the discourse among individuals, the social relationships that bind them, the physical artifacts they use and produce and the theories, models and methods they use to produce them’ (Jonassen et al, 2000).

A brief overview of some of the main theories associated with this paradigm now follows.

Socio-cognitive theory focuses on individual learning within a social situation and has two components, shared cognition and situation cognition, that focus on the individual and social aspects of learning.

Sociocultural theory focuses on the causal relationship between social interaction and an individual’s cognitive development.

Socio-constructivist theory, which asserts that knowledge is not a fixed object, asserts that knowledge is constructed by learners through their interaction with artifacts. As these are of major importance to the design of constructivist learning environments, and as this is a central focus of this study, these concepts will now be discussed in more detail.
Situated cognition (Lave 1988, 1991), also referred to as situated action or situativity, although widely used does not have universally agreed definitions. Lave, who is most often associated with this theoretical perspective, is interested in the cultural construction of meaning. Wilson (2000) states that the ‘stand-out characteristic of situated cognition seems to be the placement of individual cognition with the larger physical and social context of interactions and culturally constructed tools and meanings’. As such, Lave and other researchers are challenging the “insulated view of cognition that ignores these contextual factors”. The social and individual are not just different levels of study but are inescapably intertwined with each other.

Stein (1998) also stated that ‘to situate learning means to create the conditions in which participants will experience the complexity and ambiguity of learning in the real world’. And that situated learning often allows learners to understand how the knowledge and skills they have acquired and developed can be used in novel situations.

The construction of meaning is also seen by some from a sociocultural perspective. Gee (1997, cited in Wilson, 2000) uses the term ‘discourses’ to describe the way people respond to patterns and features in particular contexts, and goes on to say ‘discourses are sociohistorical coordinations of people, objects, ways of talking, acting, interacting, thinking … that allow for the display and recognition of socially significant identities’, and argues that within these discourses people exchange thoughts and meanings which he calls sociocultural models.

Vygotsky’s (1978) work in the area of zone of proximal development (ZPD) also relates to sociocultural theory. He defined ZPD as an area of learning activities that individuals can complete with the help of more capable peers, teachers, or artifacts. He also stated that interaction and scaffolding of learning can aid in individual cognitive growth. Essentially, an individual who learns improved problem-solving skills under the guidance of, or in collaboration with, more capable individuals can then apply the improved skills when working independently to solve similar problems.
The impact on meaning, construction of discourses and sociocultural models is critical according to Wilson (2000), even though these models or contexts may not be physically present, as may be the case in computer-supported learning environments where the learner may be interacting with the technology and not with any other individuals. People interpret new situations in the context of their past experiences, thus achieving a sense of continuity over their lifetime. So meaning can only exist by reference to the history of the person and his or her associated groups.
Figure 2.5 Overview of constructivism (after Ninia, 2004).
2.3.7 Constructivism

As was seen in the previous section, over the past 10 to 20 years there has been a move towards constructivism as a major learning paradigm. It has also become the theoretical basis for the design of learning environments. Constructivist theorists claim that learners interpret information and the world according to their personal reality, that they learn by observation, processing and interpretation, and then personalise the information into personal knowledge (Cooper, 1993, Wilson, 1997). Learners learn best when they can contextualise what they learn for immediate application and to acquire personal meaning.

Constructivists argue that learners should be active rather than passive. Knowledge is not just absorbed from external sources and artifacts or from someone else. Instead it is the individual learner’s interpretation and processing of what is received through interactions with sources that creates knowledge. The learner is the centre of the learning. The teacher assumes an advising or facilitating role.

Duffy and Cunningham (1996) argue that learners should be allowed to construct knowledge rather than being given knowledge through instruction. From this follows a major emphasis of constructivists, situated learning. This sees learning as context dependent. It follows, therefore, that learning activities that allow learners to contextualise information should be used in online instruction. Tapscott (1998) points out that if the information has to be applied in a number of contexts, then learning strategies that promote multi-contextual learning should be used to make sure that learners can apply the information broadly. With constructivism, the teaching and learning process is moving away from one-way transmissive approaches to methods that support the construction and discovery of knowledge.

Constructivism as a theory is credited originally to Piaget (1926) and is summarised in the following statement:

*Knowledge is actively constructed by the learner, not passively received from the environment.*
As with the development of other learning paradigms discussed previously, constructivism was also a reaction against existing epistemologies that promoted the transmissive mode of learning. A major feature of constructivism was shifting the emphasis from teaching to learning. Learners don’t just receive new knowledge but construct it by interacting with the world (physical and social).

What distinguishes these theories from cognitive theories is the belief that ‘knowledge’ is not seen as an object that can be passed from one person to another, rather understanding and meaning are constructed by learners through their interactions with others while actively engaging in learning tasks. Learning does not take place within a vacuum, but is a process integrated within a social context. Knowledge is negotiated and constructed through a dialogical process.

Six types of constructivism are often identified and contrasted

- trivial
- radical
- social
- cultural
- critical

Trivial constructivism was proposed by von Glasersfeld (1990) to categorise what he saw as the simplistic characterisation of constructivism. He questioned the ‘trivial’ nature of definitions that say nothing about concepts such as ‘knowledge’ or ‘environment’ or even the relationship between environment and knowledge. As a result other forms of constructivism have been proposed.

Radical constructivism (Piaget, ibid) was built on the concept of trivial constructivism and could be expressed as follows:

Coming to know is a process of dynamic adaptation towards viable interpretations of experience.
The knower does not necessarily construct knowledge of a ‘real’ world.

This deals with the problem of constructivism that seemingly allows individuals to create any reality they wish. Who is to determine what is ‘real’? This perspective does not deny an objective
reality but states we have no way of knowing what the reality might be. Might we not all live in our own dream worlds unable to communicate with others or form social groupings?

One would suppose that this could create difficulties when people try and communicate. Without shared meanings between individuals surely communication becomes impossible. However others (Hardy and Taylor, 1997) argue that it is sufficient for meanings to be compatible to allow for communication.

So while the emphasis is still on the individual as learner and constructor of knowledge, neither of these two phrasings of the constructivist framework takes into account the way in which our human/social environment affects learning.

Social constructivism takes account of all of those people who affect the social world of the learner. This includes teachers, friends, other students, administrators, technicians etc. There is a direct link between this perspective and the work of Vygotsky (1978) with his focus on the role of society in the development of the individual. It takes into account the social nature of learning processes both to the learner in his/her immediate environment and the larger social grouping in any academic discipline.

A dialectic central to this perspective is the location of the mind. Is it in the head of the individual or is it located in social action. Cobb (1994) has argued that both of these views should be used. Saloman and Perkins (1988) have suggested that the ‘acquisition’ and ‘participation’ models of learning are interrelated and interact in synergistic ways. In their model of ‘social learning of the individual’ they identify three main types of relations:

- socially mediated individual learning
- individual learners participate in the learning that takes place in groups where sometimes what is learned is distributed throughout the group rather than being in the mind of the individual
both aspects of learning above can interact over time to strengthen each other in a ‘reciprocal spiral relationship’

Wood et al (1995) assert that this means social constructivism includes teaching strategies that are personally meaningful to students. For example, class discussion, small group collaboration and valuing meaningful activities over the production of ‘correct’ answers. It is interesting to note that academic research often includes a social constructivist framework where academics draw on each others’ ideas, often combining, arguing against and extending them to construct our own social understanding of concepts and ideas: i.e. much as happened as I undertook this study over the past number of years.

Social-constructivist theory, therefore, supports learning through authentic, challenging and collaborative projects. It is based on Piaget’s work but extends this to adult learning. A pedagogic approach based on this theory relies on collaborative learning environments. Learners in these environments rely on their own frameworks and perspectives to enable them to negotiate and create new meanings and explanations through shared understanding.

Cultural constructivism takes into consideration wider influences such as custom, religion, biology, language, tools and language. It could be summarised as:

...a new conception of the mind, not as an individual information processor, but as a biological, developing system that exists equally well within an individual brain and in the tools, artifacts, and symbolic systems used to facilitate social and cultural interaction. (Vosniadou, 1996, cited in Dougiamous)

With this perspective it is argued that the tools we use influence how we think. For example, the way in which a text book is laid out can influence views about the relative importance of various concepts or ideas. Tools influence how we think in two ways: by redistributing the cognitive load between the individual and the tool being used (for example, using a phone can change the nature of conversations) and by the way tool use can change skill levels, perspectives and ways of representing the world. As Salomon and Perkins (1998) point out computers carry an entire philosophy of knowledge construction, symbol manipulation, design and exploration which, if used
in schools, can subversively promote changes in curricula, assessment and other changes in
teaching and learning.

*Critical constructivism* advocates a critical self-awareness dimension to constructivism as central to
educational reform informed by a consideration of the ethics of communication. Dougiamous states
that critical constructivism ‘...has the aim of making culturally disempowering myths more visible,
and more open to critical self-reflection’ (Dougiamous 1998).

Taylor (1996) asserts that we are immersed in cultural myths in our daily lives and that these myths
determine how we view the world and act in that world. Some myths are positive while others, such
as teacher as controller, have negative connotations. We need to question these cultural myths or
frameworks, especially if they influence our behaviour as teachers. One outcome of this
constructivist perspective is to allow the teacher to question his/her role and to move away from
being the controller.

‘Ideally, the communicative actions of teachers and students should not be restrained by
ideologically-oriented domination, coercion, or distortion associated with the technical interest ... [it] requires teachers to begin to act more in accordance with their moral accountability for the intellectual, emotional and social welfare of their students’ (Taylor 1996)

I would also like to propose a seventh type of constructivism. I call this corrective constructivism.

*Corrective constructivism* deals with the creation of flawed knowledge. Suppose the community of
practice has among its members somebody who purports to be an expert but has a basic
misunderstanding of a fundamental principle or concept. As the group members collaborate and
construct new knowledge, some of that new knowledge may not be valid. For example, suppose a
learner is working on an area of engineering and generates a new formula for measuring stresses
based on incorrect fundamental principles, and then applies this new knowledge to the design of a
bridge with resulting catastrophic consequences. Do we then not need a mechanism that enables the
new knowledge that has been constructed to be corrected? Clearly some sort of feedback
mechanism needs to be built into this model.
A common theme in these definitions is the interaction between the learner and other artifacts, be they experience, prior knowledge or other people. In the latter case we see the development of the concept of social learning as part of the constructivist perspective. But what is meant by the term social learning?

Salomon and Perkins (1998) suggest six meanings of social learning:

- Active social mediation of individual learning. This occurs when a person or a team helps an individual to learn.
- Social mediation as participatory knowledge construction. Social mediation of learning and the individual involved are seen as an integrated and highly situated system in which the interaction serves as the socially shared vehicles of thought.
- Social mediation by cultural scaffolding happens when the learner enters into some kind of intellectual partnership, or is helped by cultural artifacts in the form of tools and information sources.
- The social entity as a learning system happens where teams or organisations or other groups work as a collective to acquire more knowledge, understanding or skill.
- Learning to be a social learner is concerned with learning how to learn as part of a group or team.
- Learning social content focuses on how to get along with others, how to maintain reasonable assertiveness, how to collaborate in reaching decisions and taking collective actions, and so on.

Social learning is particularly apposite in this study. Learners worked in groups and this was closely interlinked with the constructivist pedagogy researched and developed in the series of research cycles discussed in Chapter 3 below.

The constructivist approach sees the learner as actively involved in the process of making meaning in conjunction with others. Teaching using this approach, it is argued, encourages the learner to analyse, investigate, collaborate, share, build and generate new knowledge based on what they
already know. By adopting social learning as part of the constructivist learning theory we arrive at
the concept of social-constructivism.

![Diagram of Learning Theory Perspectives]

Figure 2.6 Overview of the learning theory landscape (Concannon, 2006).

We have seen in this section that there have been a number of developments in learning theory
based on philosophical conceptions on the nature of knowledge. These conceptions have influenced
ideas in psychology which have then fed into learning theory. Figure 2.6 above gives an overview
of these learning theories.

In turn, learning theories have influenced the theory underpinning the pedagogical approach
adopted. In the next section constructivist learning environments will be discussed further.

2.4 Constructivist learning environments (CLEs)

Constructivist learning environments share a number of key epistemological assumptions. From a
constructivist perspective reality and meaning are seen as being personally defined rather than
externally or universally defined. Constructivist learning environments are underpinned by
psychological research and theories related to situated cognition. This perspective emphasises the
inter-linking of content, context and understanding and the personal negotiation of meaning and the construction of knowledge.

Land et al (2000) assert that from a pedagogical perspective there are significant differences between constructivist and traditional learning environments. The main differences are listed in table 2.6 below.

<table>
<thead>
<tr>
<th>Constructivist learning environment</th>
<th>Traditional learning environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rich, authentic context</td>
<td>Isolated and decontextualised</td>
</tr>
<tr>
<td>Student-centred</td>
<td>Teacher-centred</td>
</tr>
<tr>
<td>Goal directed</td>
<td>Teacher/externally directed</td>
</tr>
<tr>
<td>Personal perspective</td>
<td>Canonical perspective</td>
</tr>
<tr>
<td>Support for multiple points of view</td>
<td>Singular points of view</td>
</tr>
</tbody>
</table>

Table 2.6 Significant differences between constructivist learning environment and traditional learning environment.

Constructivist learning environments, therefore, support learners as they attempt to understand multiple points of view and ‘reconcile competing and conflicting perspectives’ (Land et al, ibid). In this study, the domain is concerned with the resolution of ethical dilemmas. As will be seen later this domain is ill-structured in that it does not have a singular perspective and there are multiple points of view about which ethical framework or theory to apply in given circumstances. Therefore it is more suited to a constructivist pedagogical approach that to a more traditional teaching approach.

Nunes et al (2003) have pointed out that constructivist online tutoring skills can pose particular problems for tutors and learners, even for experienced teachers and, as with any aspect of teaching, poor teaching methods will have negative effects on learners. They state that as well as subject knowledge and pedagogical skills the online tutor should ‘demonstrate additional skills’. They list the following as being important skills, (which I have annotated by reference to my own research and which will be discussed in Chapters 4 to 7):

- Learning outcomes need to be clearly specified and the delivery planned in order to specify these. In this study this was done by the development of guidelines for learners on how to use the tools and how to engage in threaded discussions.
• **Scaffolding and learning leadership needs to be provided by the setting of learning agendas.** In this study this was recognised as a necessity which again contributed to the development of guidelines.

• **The tutor should not criticise learners when they show a diverse range of outcomes, learning styles and attitudes.** The domain, which was based on ethical analysis, allowed learners to argue from different moral perspectives and they were not criticised for doing this, rather they were encouraged. The actual submissions were in some cases traditional reports and in others transcripts of threaded discussion. Thus participants were allowed total control over the style of submission. Learners were also encouraged to develop and follow their personal preferences on how to debate and discuss.

• **The support given by the tutor needs to be adapted to suit individual needs.** This was achieved by monitoring level and type of use of the ICT used in this study. It was also achieved by developing a feedback mechanism using data visualisation methods with different graphical front ends to support learning.

• **The tutor needs to ensure that they are part of the online collaborative learning process.** This was developed by guided input from tutors and formative feedback to help learners determine their own progress.

• **Skills and techniques need to be developed to resolve online conflict.** The application of accepted ‘netiquette’ behaviour assisted in this respect, and lessons learned from online conflict resolution were applied and developed.

• **Active construction of knowledge needs to be encouraged.** The main outcomes of this study were the development of tools and techniques to achieve this in the Professional Issues domain.

• **Learner feedback methods should be developed.** The final two cycles of action research in this study focused on this aspect.

• **Learners should be provided with advice to minimise cognitive overload and control pace of learning.** As will be seen later, this was identified as a problem, and required several cycles of action research to establish the parameters suitable for learners at this level in this domain.

Not only do teachers need to develop appropriate online learning environment skills, learners need to have the necessary skills to use the ICT-enhanced learning environment successfully. These skills
include the ability to collaborate effectively in an online environment otherwise the learning process is likely to be less effective and the social construction of knowledge less likely to happen. For example Darke, (1988a) cited in Hara and Kling (1999), found that students who have high levels of anxiety about the learning environment will exhibit a decreased ability in the storage and capacity of working memory and this will hinder inferencing. Furthermore high levels of frustration can demotivate learners (Jonassen et al, 1993, in Hara et al 1999).

As will be discussed in more detail later, at the outset of this doctoral research it became evident that there were a number of student frustrations with aspects of the learning approach used. Issues such as difficulty in framing ethical discussions, the size, frequency and complexity of posts, lack of skills in developing discussion threads and inability to self-assess their own work had negative impacts on learning outcomes.

Each of these issues was initially identified and subsequently addressed giving the researcher the opportunity to develop more comprehensive guidelines for both learners and online tutors. The action research approach allowed for the development and assessment of techniques and learner guidelines which helped learners to be more effective using this constructivist learning environment and thus markedly reduce their frustrations.

2.4.1 Three constructivist learner-centred pedagogies
Learning theories determine the learning principles that are adopted in the classroom. Some of these principles are illustrated in Fig 2.6 above. The learner-centred approach is one that has been in the ascendancy for some years now and there is much research on the benefits of this epistemology in third level. But what happens after deciding to use a student-centred approach? Will the students actually achieve the higher-order learning outcomes that are desired? Will they be able to adapt their learning behaviour to these teaching and learning strategies?
What is needed is the development of learning behaviours in students that can help them achieve such outcomes. In this section three pedagogies/learning behaviours are examined: problem-based learning (PBL), self-directed learning (SDL) and collaborative learning (CL). These pedagogies were chosen because they have been demonstrated to achieve the desired outcomes. They are pedagogies because they are the methods used by the teacher and they are learning behaviours because they are the strategies adopted by the learner.

Although these three learning perspectives have the common theme of a learner-centred approach to education, LeJeune (2001) has suggested that ‘problem-based learning, while conceptually standing alone, in practice requires the integration of collaborative learning and self-directed learning’.

Figure 2.7 below illustrates this relationship. He also suggests that integrating the best practices of CL and SDL into a problem-based learning experience should give students the opportunity of developing higher learning objectives.

LeJeune also mentions that included benefits of these three learning approaches are increased student motivations, active participation in learning and ‘better’ learning, which is defined as achievement of higher-order learning outcomes (Barrows, 1994, Feltovich et al, 1996). He goes on to point out that learners using these techniques ‘develop more connections among concepts, and acquire greater critical thinking skills (my italics)’. It was therefore pertinent in the context of this
research to examine these three aspects and how they might be incorporated into the design of the learning environment for PISE.

2.4.1.1 Problem-based learning
As was stated earlier, one of the main functions of learning in third level is often said to be the development of critical thinking skills. For this to happen some type of meaningful learning has to take place. It is widely debated how best this may be achieved, but as has already been suggested, problem-based learning (PBL) offers some opportunities.

This learning behaviour is the first of the three learning activities to be discussed because it encompasses SDL and CL.

The basic conception of PBL is that learners, working in groups, are initially given an authentic and complex problem to solve before any teaching of concepts has taken place. The aim is for the learners to define what it is they need to know. The process can be guided by a teacher, or the learners can work independently of the teacher, but in the latter case this may lead to incorrect solutions. However there seems to be some debate as to whether or not the process should ‘throw the learner in at the deep end’ so to speak, and some argue that a basic introduction to the problem domain aids the learning process.

LeJeune (2000) points out that the PBL process starts when learners are given an authentic problem to be resolved by a ‘small group of students’, with the group size normally between four and seven. The problem needs to be authentic and complex and should be ill-structured. As is discussed later, Jonassen (2007) has identified specific benefits from ill-structured problem solving.

Learners then need to follow an analysis process in which they first determine their level of knowledge about the problem and establish what they need to know to resolve the problem. Learners are also expected to find and use resources they individually acquire themselves. In other words, working to acquire the necessary knowledge to solve the problem.
Part of this process requires self-directed learning, (SDL) so that the learner can assess the knowledge needs for the problem, and critically determine the appropriateness of resources found. SDL is further discussed below.

Learners may work individually in the above tasks or the group members discusses and shares their resources in a collaborative manner. A key element in the PBL process is a reflection activity focusing on self and peer-evaluation of problem-solving abilities, behaviour as self-directed learners and as members of a group.

Problem-based learning (PBL) has many variations, all of which require a problem as the stimulus for learning. PBL is an educational approach, not an isolated instructional technique, and is student-centred.

Mann and Hanson (1998) have suggested four ways in which PBL can effect student learning:

- requires active processing of information
- activates prior knowledge
- provides meaningful context
- stimulates opportunities for elaboration and organisation of knowledge

PBL has, for some time, been extensively used in medical education, with claims of providing numerous benefits for professional development and learning in a way that is especially relevant to future professional practice. Other disciplines such as business (Stinson and Milter, 1996), mathematics (Seltzer, Hilbert, Maceli, Robinson, and Schwartz, 1996), architecture (Kingsland, 1996), biochemistry (Cohen, 1994) and computer science (McCracken and Waters, 1999) have used problem-based learning as a pedagogical method.

There is also a strong link between problem-based learning and collaborative learning. Barrows (2000, cited in Chernobilsky et al, 2005) has asserted that problem-based learning is inherently collaborative in nature. In problem-based learning students work in small groups under the guidance
of a facilitator and learning takes place through solving problems and reflecting on the process. The collaborative component allows the learner to share ideas and develop new and authentic solutions, and at the same time acquire knowledge of theories and concepts (Hmelo-Silver, 2004, cited in Chernobilsky et al, 2005). In problem-based learning the learners collaborate on complex problem-solving tasks and thus share the cognitive load among all those involved in this process, while at the same time group members can take advantage of the ‘distributed expertise’ (Pea, 1993) within the group.

This is also an aspect of socially-constructed knowledge which, as Roshcelle (1996) has argued, is the very essence of collaboration. From this sociocultural perspective it has also been asserted (Vygotsky, 1978) that learners internalise what they have learned by working as part of a group, thus further enhancing the learning achieved.

Jonassen (2007) also argues that meaningful learning happens when we have a problem to solve at home or in the workplace, and that therefore ‘the only legitimate goal of education is problem-solving’. However, he believes that in ‘formal learning contexts, students… “learn about” the content they are studying’ and not about the context. He asserts that learners may well know about a subject domain such as biology or sociology, but ‘they rarely, if ever, lean how to … think and act like sociologists or biologists’.

He also argues that the type of problem solving learners encounter in education environments is do
to with structured problem solving, whereas in everyday professional lives it is unstructured problems that we are rewarded for solving.

Jonassen (2007) uses six criteria to support his argument that learning to solve ill-structured problems should be central to third level learning outcomes.

*Authenticity* – it is an authentic aim of learning to develop problem-solving skills in learners by providing them with opportunities to solve problems and ‘if we don't, they will become increasingly
unable to solve the complex, collaborative, dynamic, and distributed problems of the 21st century workplace”.

*Intentionality* - Learners do not engage with the learning process unless they have the intention to learn the problem-solving techniques. This can be seen by the way users become involved when they want to solve a problem such as how to move to a higher level when playing a video game. In this situation meaningful learning is implicit in what the user is doing.

*Meaningfulness* - As we will see in the following sections, the constructivist approach of the past decade or so has shown that meaning making is most likely to happen when embedded in some authentic task. Problems provide such meaningful reasons for learning.

*Ontology* - The transmissive paradigm gives more value to content as being what the learner should know, but this is dissimilar to how humans are most likely to learn, i.e. experiential by the application of knowledge to problem solving.

*Intellectual underworld* - This will be the result of continuing with the learning paradigm of knowledge transmission. In this paradigm knowledge represents truth, and truth is what is on an exam paper. It militates against the exploration of alternatives or the construction of new belief systems.

*Design* - Finally, by adopting a problem-solving approach to the design of the learning situation a set of learning tasks can be used to help the learner to develop the problem-solving skills appropriate to his/her specific domain.

Because of the evidence in the research literature in support of this learning behaviour, a pedagogic method to encourage problem-based learning among students was developed and evaluated in this study. The ethical dilemmas which students worked on were typically ill-structured and as a consequence lent themselves to the adoption of the constructivist pedagogy which was developed throughout the research study.
2.4.1.2 Self-directed learning

The second learner-centred pedagogy to be discussed is self-directed learning (SDL).

There are many different definitions of SDL. These include:

- an instructional method (Knowles, 1975)
- a personality trait in the learner (Brockett and Hiemstra, 1991)
- a process for learning (Knowles, ibid)
- stages in the development of the learner (Pilling-Cormick, 1996)
- active involvement in the learning process (Pilling-Cormick, ibid)
- ability to define and meet learning goals (Grow, 1991a)
- a combination of one or more of these

Knowles defines SDL as ‘a process in which individuals take the initiative, with or without the help of others to diagnose their learning needs, formulate learning goals, identify resources for learning, select and implement learning strategies and evaluate learning outcomes’.

LeJeune has suggested that SDL represents:

- traits of the learner that reflect on his or her propensity toward self-directedness
- capabilities of the learner to undertake a self-directed project
- the actual process of undertaking the self-directed learning project
- the individual’s motivation toward the learning project

However, learners do not necessarily have the skills for self-directed learning, especially in an educational environment where they normally expect to be provided with ‘content’ and then examined on this. This was also the case with the students this researcher encountered.

One technique to get the learner to develop SDL skills is by getting them to identify and set their own goals (Pilling-Cormack, 1997). This framework is then developed and extended by the learners themselves as they deal with the complexities of the problem domain. The underlying pedagogical
assumption is that by providing the learner with the opportunity and some basic building blocks they will 'self teach' SDL.

SDL skills can be developed by giving the learner the opportunity of using problem-based learning (PBL). Barrows (1994) points out that among the benefits of PBL is the acquisition of skills by students 'to direct their own continued learning’, one of the features of SDL.

Candy (1991) also lists among the benefits of SDL, that it recognises the primacy of learning over teaching, leads to enhanced learning through increased motivation and models democratic principles of behaviour. The final point here has resonances with the action research methodology discussed in the next chapter.

Beach (1974) was among the first researchers to link SDL and the improvement of critical thinking. Currie, 2000 (cited in Reece, 2007) has also shown how SDL is connected to the development of higher-order critical thinking skills in the area of library information systems studies. Ramnarayan and Hande (2005) also demonstrate the link between these learning outcomes in the field of medical education.

Developing SDL abilities in learners is important as it can contribute to the success of the PBL approach. It is also a useful co-skill to attain along with collaborative learning. As will be seen in later chapters, methods were developed to encourage learners in the PISE course to acquire these skills and thus increase the likelihood of enhancing their learning experience and outcomes.

2.4.1.3 Collaborative learning

The third learner behaviour discussed here is that of collaborative learning (CL).

CL is obviously a necessary learning strategy when working in group-based pedagogies. It has also been identified as a fundamental component of socially-constructed knowledge, constructivism.

CL has many definitions depending on the perspective of the researcher. For some it includes almost any collaborative activity situated in a learning context. Other researchers focus on the
effects of collaborative learning, while others are still debating whether it is a pedagogical method or a psychological process.

For the purposes of this study CL is defined as *the activity of joint problem solving in an educational context.*

As was seen earlier, Jonassen (2001) has also shown that collaboration can be beneficial for learning by enhancing critical thinking and problem-solving skills. Salomon (1995) has also pointed out that collaborative learning can provide long-term effects, provided it also intellectually engages the learners and encourages personal responsibility. But CL must also provide opportunities for real interdependence between the necessity to share information, the division of labour, and the need for joint thinking in explicit terms that can be developed and changed by peers. This definition was useful in the evaluation of ICT which I discuss in Chapters 5 and 7.

Dillenbourg (1996) has pointed out that the necessity of having to share information meanings, concepts and conclusions is inevitable in the collaborative construction of knowledge. Furthermore, collaboration with other students has been shown to stimulate activity, make learning more realistic and to stimulate motivation. (Veerman and Veldhuis-Diermanse, 2001).

The collaborative approach to learning, supported by instructional technology, also appears to lead to deeper understanding and new knowledge creation (Mäkitalo et al, 2001, Cravener, 1999, Harasim et al, 1995).

Research has also shown that moral dilemmas in computer ethics encourage group discussion (Dukerich et al, 1990), that teamwork encourages social facilitation, better learning and higher cognitive skills (Hiltz, 1994, Salomon and Globerson, 1989) and that groups can produce better solutions to moral and ethical problems than individuals (Peek et al, 1994). Research in the area of pharmaceutical education (Latif, 2000) has also shown that peer discussions of moral dilemmas facilitate the development of moral reasoning.
The use of a problem-based collaborative teaching/learning strategy has been shown to help develop deeper understanding of subject domains (Dukerich et al., 1990). Research also shows that teamwork encourages social facilitation, better learning and higher cognitive skills (Hiltz, 1994). However, there is also a need to consider individual participation as this effects group and individual educational gains.

Some researchers (Cohen, 1994, Cohen et al., 2002, Schwartz, 1999) have found that the amount of positive peer-facilitation effect on a group’s functioning through socio-cognitive conflict is contingent at some level on equity of member participation. The greater the inequity the lower the average effect on the group performance, which is mainly influenced by a small number of dominant members. As a result this also reduces the range of perspectives and strategies, and reduces the possibilities for the group to benefit from the peer-facilitation effect owing to socio-cognitive conflict.

In this research study awareness of this potential problem influenced the development of methods to encourage equity in participation. These are discussed in Chapters 5 to 7.

Fjuk et al (1999) also argue that an effective collaborative learning environment must stimulate mindful engagement and social interaction, and they also formulated three goals for collaborative learning which hark back to the constructivist perspective:

- joint construction of problem solutions by mutual refinement
- exploring different opposed alternatives in argumentation
- students using each other as a resource

Davidson (1994) has identified five attributes of CL. These are:

- a common task or learning activity suitable for group work
- small-group learning (small enough to require direct interactions among group members)
- cooperative behaviour (as contrasted with individual learning or competitive learning behaviours)
interdependence, often referred to as positive interdependence (all group members are necessary for success)

individual accountability and responsibility (the individuals acquire the knowledge and are accountable for their own learning within the group)

Relating these attributes to this study, in the PISE module students were presented with a moral dilemma (the common task), they worked in groups of six (small group learning) and helped each other to resolve the issues raised (cooperative behaviour). They were awarded a group grade, which encouraged interdependence between members of the group. Marks were also awarded on an individual basis for personal contributions to encourage individual accountability and responsibility. This last attribute is also a component of SDL and demonstrates a further link between these two learning behaviours.

In this section I have discussed three learner-centred pedagogies: problem-based learning, self-directed learning and collaborative learning. I have highlighted research that shows that integrating these strategies can contribute to the development of higher-order critical thinking. I have also discussed the need to use ill-structured problem domains to maximise the potential of these pedagogies. The discussion also showed the link between these pedagogies and the broader, constructivist, learning paradigm.

In the next section I look at how this influences the design of learning environments.

2.5 A Design for learning environments

Land et al (2000) point out that there has been a large growth in the number of student-centred epistemologies over the past three decades. These include:

- problem-based learning
- anchored instruction
- cognitive apprenticeships
- reciprocal teaching
• constructivist learning environments,
• computer-supported collaborative learning

among an ever-lengthening list. The authors also argue that it is necessary to link ‘teaching, learning
and technology’ to help in the design and implementation of effective teaching environments.

Although different learning environments may vary in their use of technology, their scope and their
methods, Land et al (ibid) suggest that they do share assumptions about the nature of understanding
and the most suitable methods for facilitating learning. However, unlike traditional instructional
design, these approaches do not rely on any one unifying theory, and it may well not be possible to
produce an ‘inclusive design model’, but this should not detract from the desire to create the most
effective learning context for students.

The authors also suggest that a grounded design approach is necessary so that researchers can
identify ‘frameworks for analysing, designing and implementing learning environments’ that share
the same theoretical underpinnings. They propose that learning environments are rooted in five core
foundations: the psychological, pedagogical, technological, cultural and pragmatic which they
define as follows:

*Psychological*: behavioural and cognitive approaches have traditionally underpinned direct learning
instruction. More recent constructivist theories have had an impact on alternative approaches to
teaching and learning.

*Pedagogical*: these are linked to the corresponding psychological foundations. For example,
pedagogical approaches linked to behaviourism reflect objective-based views of the world, are
hierarchical organisations and use ‘tightly engineered response feedback’ activities. Cognitive-
based pedagogies focus on external strategies such as alerting to forthcoming information (‘the
main aims of this lecture are…’), amplification of key points etc.
Technological foundations: these focus on how ICT can ‘support, constrain or enhance’ the learning environment. However, it is important to consider how these technologies are used, and the appropriateness of use to the specific epistemological assumptions of the learning environment.

Cultural: This is concerned with the values of the learning community. For example, does the institution value inter-disciplinary learning, is it interested in the ‘global society’ and does it therefore encourage international collaboration? But the culture of the organisation may also influence approaches to teaching such as class size, large numbers in lecture halls, types of assessments and size of cohorts. Finally the culture foundation may determine what are acceptable assessment practices.

Pragmatic: I.e. this aspect is concerned with issues pertaining to access to ICT, labs, bandwidth and use of computers. There may also be further constraints relating to prior knowledge, language and other skills. All of these factors can constrain the design and use of any learning environment, and thus this perspective provides a ‘reality check’ on what is proposed.

The authors argue that for the successful design of learning environments, for research as well as for teaching, these foundations must be aligned. This is because as the intersection across foundations increases so also does the improvement in grounded design. These core foundations also gave a structure to this research study.

In this study the psychological theory underpinning the approach taken was that of constructivism. This in turn lead to the investigation of the adoption of a pedagogy where knowledge was constructed rather than one where knowledge was transmitted from teacher to learner.

The technological foundation led to the consideration of different learning management systems and the features that would enhance and support learner achievement and not constrain them.

The cultural aspect was a driver in so far as it was necessary to accommodate large cohorts while adopting a pedagogy that allowed for group work and individual assessment.
Finally the pragmatic foundation influenced the type of ICT used: it was necessary to consider the access and bandwidth from collaborating institutions as well as technical knowledge of web-based tools by all participants.

Anderson et al (2004) have also considered issues in the design of online learning environments. They have stated that ‘we can expect that online learning, like all forms of quality learning, will be knowledge, community, assessment, and learner centred’. Although a review of the literature indicates that there is still no one theory on which researchers are agreed that can be used as the theoretical basis for the development of online learning environments, a number of models have been suggested. In the next section these will be looked at in more detail. Bransford et al (1999) have suggested one such model and that effective learning environments are framed within the convergence of four perspectives. They identify these as:

- learner centred
- knowledge centred
- assessment centred
- community centred

These will now be discussed.

2.5.1 Learner centred

There are six aspects to the learner-centred perspective.

- **Prior knowledge** - Cognitive structures and understanding brought by learner to learning situation – teacher must understand learners pre-existing knowledge and misconceptions the learner brings to the learning situation.

- **Cultural attributes** - Learning environments must accommodate any cultural attributes of the learner including language and forms of expression.

- **Explicitation** - There should be extensive use of diagnostic tools and other activities so that any previous knowledge is made explicit to the teacher and others involved in the learning process.
• *Incentives and opportunities* – It is important to ensure that learners have incentives and opportunities to share their understandings and cultural frameworks. As is discussed in Chapter 5, in this study such incentives included awarding marks for individual student contribution to group tasks.

• *Community building* – This is an important stage in the establishment of a learning situation. It is often the most significant point at which learner misconceptions and cultural frameworks can be made evident through sharing of these with others, including fellow students. Sharing can be done formally or through activities such as ice breakers and ‘provision of an opportunity for students to introduce themselves and also express any issues of concern to the teacher and class’. This is further discussed in a later section where students from Ireland and the UK working collaboratively discussed the situation in Northern Ireland and a 2005 Orange Order march in Dublin.

• *ICT skills* - Eastin and LaRose (2000) argue that it is not just Internet skills and learners’ mastery of communication tools alone that are responsible for proficient use of online learning environments, but that these skills should allow learners to use this technology transparently and in comfort, otherwise it will become a barrier to any learning.

### 2.5.2 Knowledge centred

This is the second perspective suggested by Bransford et al (ibid). They argue that because learning does not take place in a vacuum but is grounded in a specific discipline, effective learning will be defined and bounded by the context of that particular discipline. Learners therefore need to be able to experience the language and framework of different subject areas and how the ‘world view’ of that subject is expressed in language and other symbolic methods. So, for example, a mathematician may have a different view of the world, and will use a different language to describe the world, than a sociologist.

Another aspect of the knowledge-centred perspective is the amount of support material now available to learners. This has increased massively since the development of the World Wide Web. Furthermore access is also increasing so that in developed countries most people attending third level have easy access to the Internet. This explosion in resources and content provided by the
Internet, along with the increase in access, mean that learners can now more totally immerse themselves in knowledge resources. These factors also provide almost limitless opportunities for learners to construct their own knowledge.

However, Bransford et al point out that learners also need the opportunity to reflect on their learning, as without this it ‘greatly limits one’s ability to transfer knowledge to an unfamiliar context or to develop new knowledge structures’. This supports the use of asynchronicity in the pedagogical approach used in this study, which is discussed later.

### 2.5.3 Assessment centred

Bransford et al consider the necessity for assessment to be a third central component of online learning environment models. While not giving unqualified support for summative assessments (although it is necessary for formal qualifications) they do stress the need for formative evaluation to ‘motivate, inform and provide feedback to the learner’. But as Anderson (2003) notes, this is a challenge for developers of ICT enhanced learning environments who need to ‘devise methods and tools that allow high quality assessment while maintaining learner interest and motivations’. In this study a major focus has been on how to use assessment to positively enhance learner motivation, and to consider what is an appropriate type of feedback mechanism to achieve this.

Although there is a great danger in increasing the workload demand on online teachers, there are few automated systems currently existing to alleviate this problem. Many of the online assessment tools only measure ‘shallow’ learning and would not be appropriate to assess higher-order critical thinking skills. However by developing group-based assessment strategies it can be possible to restrict this increase in assessment workload. This happened in this study and will be further explored in Chapter 4.
2.5.4 **Community centred**
The final perspective suggested by Bransford et al focuses on the important social aspect of learning environments. The authors highlight the relevance of Vygotsky’s (1978) concept of social cognition as a basis for understanding how learners work together collaboratively to create new knowledge. Lipman’s Community of Inquiry is a development of these ideas and Wenger’s (2001) Community of Practice provides further theoretical underpinning to the ideas of how learners both support and challenge each other, leading to effective knowledge construction. In effect there needs to be a sense of community among those working collaboratively in online (and distance) learning environments, and without this the potential benefits of this approach may not be realised.

Some researchers such as Harrisim et al (1995) are positive in highlighting the benefits of online distance-learning communities. Others (e.g. Mason and Hart, 1997) have noted problems with attention and participation due to lack of social awareness. Hine (2000) has also identified the lack of ‘placedness’ as a factor in limiting the benefits of this approach. So there is a need to create a sense of community in an environment where some members may never get the opportunity to meet face to face. This was a difficulty that was addressed in this study and will be considered in Chapter 6.

By placing these four perspectives, learner centred, knowledge centred, assessment centred and community centred at the heart of the design process of online distance learning environments Bransford et al assert that more effective learning can take place. In doing so the authors move from a theoretical focus to a pedagogical one which allows teachers to improve the learning experience of students and underpin this pedagogical approach. I was cognisant of, and used, these four perspectives in the design of the ICT supported learning environment that was developed during this research study.
2.6 Interaction in online learning

Dewey (1916) proposed that interaction is the defining feature of the educational process which happens when a learner creates personal knowledge by transforming information passed to him/her by another. ICT has a major educational function by facilitating interaction between all the participants in the teaching and learning process.

Garrison and Shale (1990) suggest that all forms of distance education involve interaction between content, students and teachers. An examination of the many ICT-enhanced learning environments shows this to be so, and also that ICT has been used to assist this interaction.

Sims (1999) listed a number of different functions of interactivity in educational contexts. These are learner control, adaptation of programmes as a result of learner input, allowing different types of participation and communication and aiding meaningful learning. Interactivity has also been identified as being fundamental to the creation of learning communities which, as has already been seen, many researchers (Vygotsky, 1978, Lave, 1988, Lave and Wenger, 1991, Jonassen 1991) have identified as fundamental to a constructivist approach to learning.

2.6.1 Types of interactions

Anderson (2002) has suggested three types of interaction as illustrated in Fig 2.8 below. These are student-content, student-teacher, teacher-content. However, other interactions can and do occur such as student-student; teacher-teacher and content-content (such as automatic updating carried out by intelligent agents of user profiles based on user behaviour).

Other researchers have also attempted to identify the different types of interaction that occur in a learning context. Moore (1989) listed three types of interaction: student-student, student-teacher and student-content. In this study the first two have been the focus of attention along with how to improve the level and type of interaction.
Student-student interaction, it has been suggested, has a number of benefits to the learner. As has already been seen the constructivist approach stresses the importance of learner-learner interaction in the development of new knowledge constructs. Slavin (1995) argues that collaborative work, i.e. interaction between students, shows gains in cognitive learning tasks alongside an increase in rates of completion of learning tasks and development of social skills. Forms of ‘reciprocal teaching’ have also been shown (Damon, 1984) to provide benefits for learners, while peer interaction is critical in the development of learning communities (Wenger, McDermott and Snyder, 2002).

Student-teacher interaction can also be enhanced by the use of ICT and in ways that are not possible in traditional face-to-face situations. Teachers in third level can interact in a number of ways. Interaction can happen in the lecture situation when presenting learners with new knowledge. Teachers can interact when assessing learners and interaction occurs when discussing and explaining new concepts in a tutorial setting.
Student-content interaction has been central to learning environments since the dawn of teaching. Historically this involved library study, reading textbooks or engaging with experts in the lecture room or in tutorials. Nowadays, as has already been seen, learners also have access to large amounts of content on the Internet and in electronic repositories.

The former two aspects of interactivity have been studied in some detail, and proposals made as to how these can be improved in the findings and recommendations for pedagogical improvements. However, Anderson (2002) has pointed out that:

\[
\text{sufficient levels of deep and meaningful learning can be developed, as long as one of the three forms of interaction (student-teacher; student-student; student-content) is at very high level. The other two may be offered at minimal levels or even eliminated without degrading the educational experience.}
\]

In this study improvements in student-student and student-teacher interactions were investigated to ascertain if they can enhance the learning process and facilitate improvements in higher-order critical thinking skills.

2.7 Enhancing higher-order critical thinking skills

We have seen in earlier sections of this chapter how learning theory has developed and how more recent theories support the constructivist approach to learning. We have also seen how this paradigm can be used as a basis for ICT-enhanced learning environments and to support interactivity, especially student-student and student-teacher interaction. Plus we have also seen how collaborative learning as a learning behaviour has positive effects on self-directed learning and problem-based learning pedagogies.

However, there are two further issues that need considering at this stage:

- What are the links between ICT-enhanced learning environments and developing higher order critical thinking?
- How can learning be supported with ICT?
In this section research from the field of computer-supported collaborative learning will be examined to see how this can help develop an ICT-enhanced constructivist pedagogy that is effective in the development of higher-order critical thinking skills.

2.7.1 Learning outcomes
Bloom et al (1956) have outlined a taxonomy of global educational goals that are commonly used to determine the learning outcomes that students are expected to achieve in a given course or module. Reeves (1990) has considered this taxonomy to help in teaching business ethics. I have done similarly but in the context of PISE.

Bloom proposed three learning domains: Cognitive, Affective, and Motor Skills. I have focussed on the first two as they are more relevant to this study. The latter taxonomy is more appropriate to academic disciplines that involve physical activity such as sport or playing a musical instrument.

Bloom's hierarchy of learning objectives for the cognitive domain identified six levels of learning which represented increasing levels of cognitive complexity from the lowest level of Knowledge (or Remembering) through Comprehension, Application, Analysis, Synthesis and Evaluation.

Learners can demonstrate learning at the higher levels by the achievement of higher-order learning outcomes associated with particular modules of study. This taxonomy is illustrated in Fig 2.9 below.

![Bloom's hierarchical taxonomy of learning](image-url)
Anderson et al (2001) have also suggested a hierarchy of learning outcomes which is a modification of that of Bloom et al (ibid). There are still six levels, but the highest two have been swapped. In this taxonomy verbs describe the increasing levels of cognitive complexity: 

- Remember,
- Understand, Apply, Analyse, Evaluate and Create. This is illustrated in Fig 2.10 below.

Anderson et al (ibid) have defined the three higher levels as follows:

*Analyse* - encompassing differentiating or distinguishing, organising or structuring, and deconstructing (which concerns determining the values underlying presented material).

*Evaluate* - which breaks down into the two processes of checking for internal consistency and critiquing which involves judging against external criteria.

*Create* - which involves generative processes such as hypothesizing, planning, designing and producing or constructing.

These were particularly pertinent in this study and supported the assessment method developed.

This is discussed in Chapters 6 and 7.

![Figure 2.10 Bloom’s taxonomy as revised by Anderson and Kratwohl (2001)]
Bloom’s Affective Domain also provided a useful framework for ensuring learning occurs at the appropriate level in PISE. This domain focuses more on the emotional component of learning, and ranges from a willingness to receive information to the integration of beliefs, attitudes and values. There is a resonance here with the development of individual ethical and moral reasoning, a fundamental aim of PISE.

In this domain five levels are identified. These are *Receiving, Responding, Valuing, Organisation* and *Characterisation*. They are illustrated in Figure 2.11 below.

![Figure 2.11 Bloom’s Affective Domain of Learning Outcomes.](image)

The first level, *Receiving*, only requires a learner to be exposed to ideas and concepts relating to PISE. At this level the student will have received input from lectures and interaction with content.

At the second level, *Responding*, Bloom is referring to a student response to the learning. This is typically demonstrated by completion of an assignment or other task. The learner might only respond because of fear of bad grades, but may also engage in the activity because of a growing interest in the subject domain.

The third level, *Valuing*, is when the learner starts to value the subject matter and might start to feel that ‘PISE is in fact an important topic for a CS degree student’.

The fourth level, *Organisation*, is concerned with the internalisation of a value system. At this level it would be expected that a learner can argue for or against an ethical framework or decision in the computing domain.

67
The fifth and final level, *Characterisation*, is concerned with how a learner can be perceived. For example, if a person is characterised as a highly honest person then enough values must have been internalised so that the ‘honest’ characterisation fits the person.

There is a resonance with Aristotle’s Virtue Ethics here which is discussed further in Chapter 4.

Bloom links his Affective domain taxonomy to pedagogy. He argues that while a good lecturer might manage to get a student to the first two levels, the final three levels require *participative* learning. And participative learning can be encouraged by a collaborative pedagogy. Finally, as was discussed previously, collaboration with other students has been shown to stimulate activity, make learning more realistic and to stimulate motivation (Veerman et al, 2001).

### 2.7.2 Links between developing higher-order critical thinking and collaborative learning

In the previous section we have seen how higher order critical thinking skills have been suggested in terms of taxonomies. In this section the focus is on other research on pedagogies as ways to encourage these thinking skills.

Educational research has identified that learners often adopt either ‘deep’ or ‘surface’ learning strategies. With surface learning the student focuses more on the testing aspect of the educational experience and skims over the material, memorises it and hopes to regurgitate it in exams. With deep learning the student tries to develop a deeper understanding of the material and to integrate it into their knowledge (Gibbs and Jenkins, 1992).

Other research (Biggs, 1987, cited in Newman et al, 1987; Lipman, 1991) associated deeper learning with social interaction such as group-based approaches to learning. Lipman (ibid) also argued that a ‘community of inquiry’ was essential to the development of higher-order critical thinking skills, and that such a community requires a group-based approach to develop.
Newman et al (1997) also contend that there is a relationship between critical thinking, group learning and deep learning. They believe that critical thinking is a key skill that is required in deep learning, that group learning provides a useful educational context for developing critical thinking processes and deep learning styles, and that group learning also promotes critical thinking through group interaction. This relationship is shown in Figure 2.12 below.

According to Vygotsky (1978), learners are capable of performing at higher intellectual levels when asked to work in collaborative situations than when asked to work individually. Group diversity in terms of knowledge and experience contributes positively to the learning process.

Bruner (1985) argues that cooperative learning methods improve problem-solving strategies because the students are confronted with different interpretations of the given situation. The peer support system makes it possible for the learner to internalize both external knowledge and critical thinking skills and to convert them into tools for intellectual functioning.
Johnson et al (1986) have stated that there is ‘persuasive evidence’ that cooperative teams achieve at higher levels of thought, while Toten et al (1991) point out that shared learning gives students the opportunity to ‘engage in discussion, take responsibility for their own learning and thus become critical thinkers’.

Gokhale (1995) conducted an empirical research study to see if collaborative learning enhances critical thinking. The study compared students who worked individually with students in collaborative groups, and measured their performance on critical thinking tests following a learning period. The author reports that:

*After conducting a statistical analysis on the test scores, it was found that students who participated in collaborative learning had performed significantly better on the critical-thinking test than students who studied individually.*

Additional research (Crook, 1999, Dillenbourough, 1999) also identified the positive effects of social interaction during learning.

In relation to PISE-type modules, there is further research in the area of problem-based learning as a pedagogical approach that shows benefits to the learner. Specifically, research indicated that moral dilemmas in computer ethics encourage group discussion and that the resulting teamwork encourages social facilitation, better learning and higher cognitive skills (Hiltz, 1994, Saloman and Globerson, 1989). Furthermore there was also evidence to suggest that groups can produce better solutions to moral and ethical problems than individuals (Peek et al, 1994).

McMillan (1987) investigated 27 studies on specific pedagogical approaches but found no single variable that was responsible for consistently enhancing critical thinking. One of the conclusions drawn from the study was that a semester is simply too brief and isolated to have an impact on critical thinking. McMillian’s findings have, however, been criticised. McKeachie et al (1986) looked at McMillian's study from a meta-analysis approach, and concluded that instruction that stresses student discussion and places emphasis on problem-solving procedures and methods may enhance critical thinking.
On the other hand, and also in contrast to the McMillan review, Luppicini (2007) in an extensive review of research into computer mediated communication (CMC) found that students in CMC groups ‘tended to outperform face-to-face groups’. They found that there were a number of empirical studies that showed positive advantages for reflective thinking, something that is a function of asynchronous CMC.

Pascarella and Terenzini (2005) point out three strategies that positively relate to gains in critical thinking:

- the degree to which faculty encouraged, praised or used student ideas (teacher behaviour)
- the level in which students participated in class and the cognitive level of the participation (learner behaviour)
- the extent of peer-to-peer interaction (course design)

The first of these can be translated in part into feedback elements, and in this study this was investigated. The second strategy was encouraged in this study by the use of asynchronous discussion and the use of ‘audit’ trails to enable the lecturer to keep track of student involvement. This also enabled the encouragement of those who were contributing less to the group-based process. The third strategy re-states the collaborative approach to learning, and was also the subject of investigation, resulting in the development of feedback mechanisms which are discussed in Chapters 6 and 7.

Perry (1970) argues that critical thinking can be developed by advancing intellectual attainment through stages (note that there are actually nine distinct stages in Perry’s schema, but only three are pertinent to this study):

- **Dualistic** or right-verses-wrong stage. This is when learners see the world in dichotomies, e.g. black or white, right from wrong, best or worst, etc.
- **Multiplicity** stage in which facts are seen in terms of their context. In this stage the students learn that the world is a little more complex than two different views in that there is sometimes more than
a single viable position on an issue. Here they start to see the ‘shades of grey’ and they realize there are multiple views.

*Contextual-relativism* stage when the learner can make intellectual commitments within a context of relative knowledge by weighing all the variables and then debating and choosing sides based on that evaluation.

As the learner moves through these stages the importance of collaborative learning increases. By debate and discussion on moral dilemmas in the computing domain the students in PISE became aware of other ethical views. These often affected previously held ethical beliefs, and also showed that the world of ethics was not clear cut. By debate and discussion with fellow group members learners were then able to evaluate their standpoints.

However, for the tutor to be aware of this development of critical thinking skills, he/she also needs to be aware of the ongoing discussion and collaboration. A major problem with large cohorts in PISE meant this was practically impossible. So a further focus on the potential for using ICT to support collaborative learning developed. The research basis for this is discussed next.

### 2.7.3 Benefits of ICT-enhanced learning environment

Laurillard (1993) in her work on critical dialogue between students identified the potential for two-way communication technologies. She suggested that these technologies can provide opportunities for interaction that can lead to reflection and deeper understanding. In other words, tools that can aid group-based collaboration. Bullen (1998) further identified the type of tools that might be appropriate to this study when he concluded ‘that computer conferencing should be given serious consideration … as a way of facilitating interaction and critical thinking’.

Bonk and Reynolds (1997) have argued that for ICT-enhanced learning environments to be successful, it is the instructional strategy that influences the quality of learning rather than the technology. However, they also point out that the learning environment and tools must provide
functionality that allows for the creation of challenging activities that will enable the learner to acquire meaningful knowledge by linking new information to old, and allow the learner to use his/her metacognitive abilities.

Other researchers have also identified the importance of teaching strategies, and the limited role ICT has in the learning process. Kozma (2001) asserts that while the particular attributes of computer systems can influence learning outcomes, it is not the computer per se that makes a student learn, but how it is used and how the student interacts with the learning environment that is important. Ring and Mathieux (2002) also argue for high authenticity, high interactivity and high collaboration. These research findings had an impact on this research study and the way ICT was used.

There is also evidence that ICT-enhanced learning environments combined with ill-structured problem-solving can contribute to better learner outcomes and to learner satisfaction.

In one study Jonassen et al (2001) compared how groups solve ill-structured problems in face-to-face and in computer-mediated asynchronous groups. In the study they examined patterns of communication and satisfaction rating for members of face-to-face and CMC groups. The CMC conducted their groupwork using computer-mediated discussion forums and did not meet face-to-face.

For the CMC group the primary advantage identified was the flexibility of this approach in terms of time and location on interactivity. A second advantage was the increased time to think and reflect and the greater participation of group members in the problem-solving activity when compared to face-to-face groups. Members of CMC groups perceived higher quality and more satisfying experiences than in face-to-face groups. Members who worked collaboratively in CMC groups felt that there was a higher quality problem-solving process and were happier in their group activities than their face-to-face counterparts. The reason given for this was that the flexibility afforded by the CMC approach was conducive to reflective thinking.
As Jonassen et al (ibid) say ‘… computer-mediated communication appears to support problem solving by eliciting more focused, on-task, and purposive communication [and this] is a significant finding. The findings of the Jonassen study further validate the approach adopted by this researcher.

Finally, there are also practical advantages to using CMC:

- it is easier to measure individual contributions than in face-to-face situations because an audit trail is created
- it easier to deal with situations where some individuals gain more from the process than they input as individual contributions can be identified.

Educational research has also shown that there is a potential major problem with the use of group-based approaches when it comes to assessment. This is primarily due to the possibility of some individuals gaining more than they have input to the process, a term that has been called 'free-riding' (Shepperd, 1993). Although research also suggests that groups need to be large to increase the advantages to members, this often increases the occurrence of free-riding due to the difficulty of monitoring large numbers of students (Veerman et al, 2001).

There is also the important question of which ICT to use. As a result of research into CSCW a number of web-based collaborative systems have become available in the education field. Bentley et al (1997) identified a number of advantages of these tools:

- they are platform independent
- access is geographically independent
- web browsers are now commonly available on most computers
- there are generally high levels of literacy when it comes to using this type of tool
- many of these tools allow both synchronous and asynchronous collaboration

There are two broad approaches to computer conferencing, as identified by Bentley et al in the final point above. These were the synchronous and asynchronous approaches. Synchronous tools were
based on immediate responses, whereas asynchronous tools incorporated a delay between the initial posting and the response.

There is also a growing body of research that indicates that asynchronous discussion reflects high level cognitive processing (Järvelä and Häkkinen, 2002, Meyer, 2003).

Veerman et al (2001) showed that asynchronous tools compared to synchronous tools can provide learners in online group discussions with more options to think and reflect on information and to organise and keep track of discussions. Learners can also use the time delay to research and find information to support their discussions and then use this information to respond to earlier arguments. This is less likely to happen in synchronous discussions. In one study (Meyer, 2003) it was reported that students mentioned specifically how they would take time to read other posts, think about a response, prepare a response and then check later to see other contributions to ongoing discussions.

Schellens et al (2004) have also found that collaborative learning in asynchronous discussion groups significantly contributes to the observation of a higher proportion of ‘high phases of knowledge construction’ than in face-to-face groups. Further research (Mäkitalo et al, 2001) also indicated that a collaborative approach to learning supported by instructional technology led to deeper understanding and new knowledge creation.

2.7.4 Online learning communities
There are many definitions of online communities in the research literature. Among the most common features are the ability to build mutual trust, a sense of belonging or community, a feeling of support, an ability to share resources, communications and problem-solving (Moore and Brooks, 2000, Shea et al, 2004,).

Palloff and Pratt (1999) have listed factors that can help identify when a community has formed, as just putting a group of learners together does not automatically create a community. These include:
• active incorporation of course content and personal interaction
• student-student interactions more than student-lecturer communications evidencing collaborative learning
• meaning that is socially constructed shown by discussions aimed at gaining agreement on issues of meaning
• sharing of resources among learners
• learners giving each other expressions of support and also critical evaluation of each others’ work

As Pallof and Pratt (2007) also point out, online learning communities allow for

‘mutual exploration of ideas, a safe place to reflect on and develop those ideas, and a collaborative supportive approach to academic work’.

These characteristics needed to be easily facilitated, and the choice of ICT in this study was instrumental in facilitating the building of online-learning communities.

Online learning communities are different from other online communities such as newsgroups or bulletin boards. In the latter there is little evidence of reflective practice, which is a feature of transformative collaborative learning (Pallof et al, 2007). Gunawardena et al (1997) cited in Pallof (2007) suggest that there are five phases through which online learning communities go in the social construction of knowledge.

Sharing and comparing information. This is characterised by communications that are designed to test the level of knowledge among group members.

Finding areas of potential disagreement. In this phase group members seek out dissonances or inconsistency of ideas. It can create conflict among group members. This phase should be welcomed as it allows the group to discover individual members’ views.

Negotiation of meaning as a result of the previous two phases. Meaningful discussions can start appearing at this stage.
Testing of ideas against facts. Facts can be personal experiences among group members or content provided in course materials.

Demonstrating emergence of metacognitive statements that show the learners’ thinking has changed – e.g. ‘I didn’t think studying ethical problems was important until I came into this class, now I can see its relevance and importance.’

So it is important that the successful use of online-learning communities involves not just appropriate tools but also collaborative exercises that encourage the development of the online group and the social construction of knowledge.

In order that groups become established and that interaction starts happening among members, certain processes may need to be introduced to encourage online socialisation. This socialisation phase has been identified to help in building trust (Jarvenpaa and Leidner, 1998). This process is important to the development of virtual teams and can be achieved through social communication such as exchanging names, interests and other personal information.

However, scaffolding of activities may also need to be implemented to encourage further interactions, especially if the process on knowledge building is slowing down. In this study scaffolding methods were developed by the implementation of a framework for online collaboration, which was one of the outcomes of this research. This is discussed in Chapter 6.

2.8 Conclusion
In this chapter I have discussed how different philosophical conceptions of the nature of knowledge, the mind and reality have been the basis for different learning paradigms. The main theories that have been proposed are behaviourism, cognitive theory and constructivism. These theories, in turn have been the basis of a range of learning principles which have influenced the design of learning environments.
I spent some time looking at the constructivist paradigm as this is a learning theory that coincides with my philosophical belief of the structure of knowledge and my educational philosophy of student-centred learning.

Developing higher order critical thinking skills is a fundamental aim of third level education. How collaboration can be used to enhance the achievement of these outcomes was then discussed.

Constructivism also provides a basis for the design of learning environments and has implications for the way in which knowledge is socially constructed. The use of ICT and the way these tools can be used to support this pedagogy in online learning was examined.

I discovered a body of evidence that:

- ICT can support critical dialogue between students
- ICT can aid group-based collaboration
- computer conferencing that had been developed in the context of computer-supported collaborative work (CSCW) had a potential application in education
- students can benefit from the use of asynchronous communication
- this form of communication operationalised by ICT contributes to ‘high phases of knowledge construction’, and high levels of cognitive processing

The aim of this chapter has been to provide the reader with the theoretical basis that underpinned the pedagogy being researched in this study. Further research issues will be discussed and developed in conjunction with the different research cycles in Chapters 5 to 7 following.

In the next chapter issues related to research methodology will be considered.
3 Methodology

3.1 Introduction

In the previous chapter it was seen how philosophical debate has taken place concerning the meaning of reality and definitions of knowledge, the ontology and epistemology of knowing. That debate had consequences for the theoretical basis of psychology, how we behave cognitively and how we learn. In turn the ontological and epistemological argument was used by educators to determine pedagogical models, and more recently into how ICT can enhance the learning environment.

However, the philosophical debate has also underpinned how research is undertaken. It has led to different research methodologies and discussion on the validity of these different research methods. But why should we be concerned with this debate?

Figure 3.1 Overview of philosophical paradigms and their relationship to research methods (after Concannon 2007)

Marshall and Rossman (2006) argue that it is vital that we involve ourselves in this debate, that the arguments as to the function of research have not been decided and that pressures exist to influence how research is undertaken. As they point out in relation to the situation in the USA:

*The current conservative federal government now stipulates that appropriate - and acceptable - inquiry can only take one form: the randomized, controlled experiment.*

And this stipulation is written into the terms governing federally funded research programmes in education, thus forcing researchers to follow a positivist, objectivist and realist research
methodology. Should that stricture have been applied in Ireland, this study might not have been possible.

In this chapter I will first be looking at the philosophical debate in terms of research methodology. Then I will discuss the methodologies appropriate to this study, and finally which methods have been used for data collection and analysis. Knight (1999) calls this ‘sensemaking and claimsmaking, i.e. providing the reader with enough information in the form of data and results so that sense can be made of the interpretations and the claims that are made in this study.

3.2 Reality and how we perceive it

Knight (2002) states that there are two broad positions often adopted relative to the nature of reality:

- the ontological perspective which considers what is reality
- the epistemological perspective, how we can know about reality or perceive it.

The first he refers to as realist, also known as positivist, and the second as anti-realist.

He argues that there are two consequences that follow from the position a researcher takes:

- researchers may be able to put forward different, opposing, claims
- some research methods are more suited to a realist or anti-realist perspective than others

It is therefore imperative that the researcher is aware of these epistemological and ontological viewpoints before undertaking research. In the next section I will consider these different perspectives.

Searle (2000) explains the realist approach, putting forward the following four claims:

- there exists a real world independent of us
- there is an objective way that things are in the world
- we ought to be able to say how they are
- if we can say how they are (by undertaking research) then what we say is objectively true (or false if that is what the research has discovered)
A strong anti-realist position denies each of these claims. Some anti-realists believe that reality is essentially constructed, that it is a social artefact that is a product of the individual mind and the form of language used to describe reality. Some, such as Rorty (1991), argue that there are no certainties, just social constructs. It follows then that research should only consider social constructs, how they are formed and sustained. Scott and Usher (1996) are enthusiastic about how these ideas have potential for educational research because it gives this research methodology the role of deconstructing, questioning and challenging viewpoints that are taken for granted. Therefore this perspective allows for a research approach that is also an agent for change. As we will see later, this also is a feature of action research.

Anti-realists have particular reservations about the realist claims, especially Searle’s final point above. They argue that either truth is an illusion or it is always contextual and conditional or that it is elusive in some other ways. And this has obvious implications for research. For example, if truth is always dependant on context then can a researcher ever generalise? Should a researcher even attempt to generalise, or merely describe the particular setting or context of the research and its findings?

Some anti-realists may accept that Searle's claims can hold true for an epistemological perspective of the physical world (although quantum physics suggests that the observer can affect the physical world, thus affecting what is being observed and therefore never actually seeing the physical world as independent). Searle's four claims are more vulnerable when applied to human thought and action. For example, consider the research question of trying to find out why people drive while under the influence of alcohol instead of just when they are more likely to do so. A realist approach might identify the types of people who behave in this manner, but would not necessarily tell the reader why this behaviour is adopted. As a result, people's feelings, opinions and the meanings they attach to events are less likely to be discovered.
Social researchers, and educational researchers, are interested in things that are subjectively intertwined with their subjects. As Knight (2002) says, ‘things in which social researchers are interested are…quite literally, subjective’. However, concerns about the realist claims are somewhat lessened when the researcher is interested more in the recording of behaviours than in the ‘meanings, beliefs, feelings, attributions or self-theories.’ Knight (2002).

Knight goes on to point out that some areas of research are more suited to realist methodologies and others to anti-realist. A pragmatic, critical-realist, position holds that some aspects of the world can be explained using realist terms, but that others are observer relative, that social phenomena may have observer-dependent elements.

Realists, on the other hand, argue that reality does exist independently of us and that our understanding of reality is a social construct that we are continually testing to ascertain its validity.

3.2.1 Perspectives and research methods
Opie (2004) illustrates some of the main features of the extremes of these two perspectives.

The positivist perspective, or ‘hard research’ uses quantitative, objective, experimental techniques in an attempt to prove theories. The researcher is an outside observer adopting an impersonal stance and statistical analysis is often used to prove a theory (or to be more precise, to disprove the null hypothesis.)

On the other hand the anti-positivist or ‘soft research’ approach uses qualitative, subjective, naturalistic techniques. The researcher is often ‘inside’ the research and may even be the subject of the research. This perspective is individualistic and the research is as much about generating theories as about proving existing beliefs.
So, the question has to be asked, what are the ramifications for research of applying these distinctions? Knight suggests the following to summarise these.

<table>
<thead>
<tr>
<th>Positivist Approach (Hard research)</th>
<th>Anti-positivist approach (Soft research)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantitative research techniques</td>
<td>Qualitative research techniques</td>
</tr>
<tr>
<td>Objective</td>
<td>Subjective</td>
</tr>
<tr>
<td>Experimental</td>
<td>Naturalistic</td>
</tr>
<tr>
<td>Pure</td>
<td>Applied</td>
</tr>
<tr>
<td>Outsider research</td>
<td>Insider research</td>
</tr>
<tr>
<td>Statistical analysis</td>
<td>Non-statistical analysis</td>
</tr>
<tr>
<td>Impersonal</td>
<td>Individual</td>
</tr>
<tr>
<td>Certain assumptions taken for granted</td>
<td>Taken for granted assumptions investigated</td>
</tr>
<tr>
<td>Macro concepts: society, institutions, norms, roles and positions</td>
<td>Micro concepts: individuals, personal constructs, negotiated meanings</td>
</tr>
<tr>
<td>Generalise from specific</td>
<td>Interpret the specific</td>
</tr>
</tbody>
</table>

Table 3.1 The differences between positivistic and anti-positivistic approaches (Opie, 2004).
<table>
<thead>
<tr>
<th>Perspectives Features</th>
<th>Realism and Positivism</th>
<th>Critical realism and pragmatism</th>
<th>Anti-realism &amp; anti-positivism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mostly applied to:</td>
<td>Natural sciences, studies of ‘objective’ phenomena</td>
<td>Natural phenomena, applied sciences, professions, social science, history and politics</td>
<td>Aesthetics and ethics, anywhere the focus is on the subjectivity of human experience</td>
</tr>
<tr>
<td>What exists?</td>
<td>Strong form: there is a physical and social reality. Weak form: does not insist on aesthetic and/or moral truths.</td>
<td>Physical world and social facts exist independent of the observer but can be experienced differently. Aesthetics and ethics are socially shaped so hard to claim that there are any transcendent truths</td>
<td>Strong form: Our minds tell us what exists. Weak form: Socially shaped language wraps up our experience of the world making it misleading to talk of ‘reality’.</td>
</tr>
<tr>
<td>What may we know.</td>
<td>True knowledge corresponds to reality which can be known through facts.</td>
<td>There are different perspectives on truth so it is impossible to know if truth fully corresponds to reality.</td>
<td>Reality may not exist. Knowledge reflects perspectives and is locally negotiated. It cannot be value-free. Knowledge is created in discourse.</td>
</tr>
<tr>
<td>(ontological perspective)</td>
<td>Truth can be known through diligent inquiry.</td>
<td>Truth is situated.</td>
<td></td>
</tr>
<tr>
<td>How do we know reality?</td>
<td>Unlikely that established theories will be overturned but not impossible especially in natural sciences.</td>
<td>In some areas, e.g. history beliefs may be displaced.</td>
<td>Knowledge is temporary, situated, contextualised, and a personal construct. But this may not apply to natural sciences.</td>
</tr>
<tr>
<td>How secure is knowledge?</td>
<td>Reality is homogenous so samples can be generalised from.</td>
<td>Reality is local and contextualised. No two samples are equivalent.</td>
<td></td>
</tr>
<tr>
<td>Sampling methods</td>
<td>Reductionism and control of variables in isolation enables complex systems to be understood.</td>
<td>With social practices parts cannot be treated like atoms. There is a need for naturalistic inquiries in real life contexts.</td>
<td>Reality is about search for meaning not causes. Systems have emergent qualities. The whole is greater that sum of parts. We cannot fully know the whole by studying the parts.</td>
</tr>
<tr>
<td>Can complex systems be understood by studying their parts?</td>
<td>These can be known.</td>
<td>Some may be identified through experimental methods, e.g. in psychology correlation methods.</td>
<td>Only tentatively identified. Argue that classical ideas of cause and effect are mistaken. Knowing is about creating webs of meaning not isolating causes.</td>
</tr>
<tr>
<td>Cause and effect</td>
<td>Can generalise from sample to larger population.</td>
<td>Rigour is valued but positivist methodology cannot necessarily be achieved. Any generalisation is dependent on researcher making a rigorous case.</td>
<td>Generalising is part of perception and readers will try to make sense of research findings by generalising. It is consolidated by language and shared social practices.</td>
</tr>
<tr>
<td><strong>Prediction</strong></td>
<td>Generalisations as laws allow for predictions, e.g, Newton, Einstein etc.</td>
<td>Researchers need to make the case for generalisation by showing rigour in research methods.</td>
<td>Free will, uncertainty, complex and dynamic world is in opposition to prediction.</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Reliability of methods</strong></td>
<td>Fundamental and necessary. Observer needs to be objective.</td>
<td>Need to be unbiased as far as possible, but humans can never be totally objective. Objectivity only exists within a culture or the researcher’s background or position.</td>
<td>Exploring meanings and understandings are obstructed by quest for reliability. No such thing as objective researcher. Need for honesty. Accuracy is based on a misconception of truth denied by this position.</td>
</tr>
<tr>
<td><strong>Knowledge and its relationship to action or practice</strong></td>
<td>Knowledge is the goal. Practice is another matter. Different views on how far knowledge ought to be useful and two what extent inquiry should have practical value.</td>
<td>Dewey’s position summarises this view. Knowledge and action combine in praxis, as we think about the way we might go about something, we change what we might aim at. There is a continual interplay between ends and means. In praxis there can be no prior knowledge of the right means by which we realise the end in a particular situation.</td>
<td></td>
</tr>
<tr>
<td><strong>Data sources and inquiry methods</strong></td>
<td>Surveys, interviews, highly structured questionnaires, experiments, rating scales, Likert, repertory grid, concept mapping, sociograms, psychometric tests, physiological measuring.</td>
<td>Looser higher inference methods. Natural and quasi experiments, semi or lightly structured questionnaires, interviews and observations. Less concern about objectivity in using positivist data sources. Also focus groups, action interviews, analysis of critical incidents, diaries, journals, photos, documents in general, post-empirical approaches.</td>
<td>Full participation in research situation as in ethnographic work. Emphasis on in depth naturalistic inquiries. Anything goes for methods, data and interpretation. Everything is contexted and changing and everything can be deconstructed.</td>
</tr>
</tbody>
</table>

Table 3.2 Comparison between different perspectives on the perception of reality and the design of research studies. (Based on Knight, 2002).

It should be noted, though, that this table is not prescriptive and that there is fluidity between the extreme positions.
Knight’s overview shows how researchers with a particular ontological and epistemological perspective cluster around some research methods. But Knight ‘insists’ (his choice of word) that methods are not bound to ontologies and epistemologies. As he points out, some writers, (Machado et al, 2000, for example) show that certain disciplines, psychology is the example given, are defined in positivist terms and are centred on the collection and analysis of quantitative data. However, at the same time, other methods are not totally renounced in psychological research design, although it may be more difficult for researchers to justify a non-positivist approach. In this type of situation researchers may be forced to ‘fall back on even greater degrees of clarity, rigour and precision’ as Searle (2000) cited in Knight, says.

So, as can be seen, the underpinning thesis of the positivist extremity is that reality exists outside of the observer and therefore its properties can be measured by adopting an objective scientific method instead of using the subjective, reflective or intuitive techniques of the anti-positivist. On the other hand, critics of the positivist approach argue that it is high in artificiality and that the specific situation being studied may not be generalisable. They also argue that this approach is also low in ecological validity, i.e. the experimental situation often does not approximate ‘real life’, and therefore the positivist perspective is not suitable for research in the social sciences.

Finally, those who adopt an anti-positivist perspective also argue that as meaning is developed subjectively and non-scientific tools are more appropriate to enable understanding of the nature of the research area.

As can be seen from the table 3.2 above, this dichotomy between Realism and Positivism (hard) and anti-Realism and anti-Positivism (soft) perspectives illustrates extreme positions. Knight therefore goes on to suggest a ‘middle’ way, Critical-realism or Pragmatism which draws on each of the extremities in the research perspective adopted.

This perspective has a number of advantages in that:
• it enables the researcher to select from a range of data collection and analysis methods using an approach often referred to as ‘triangulation’ (Cohen, Manion, and Morrison, 2000), (as discussed 3.2.2 below).

• it allows for more naturalistic inquiries in real life contexts.

• it is rigorous without the need for the positivist reliance on statistical proofs

• it is not so concerned about objectivity in using positivist data sources

• data sources and inquiry methods suggested are more natural and quasi-experimental using semi- or lightly structured questionnaires, interviews and observations, focus groups, action interviews, analysis of critical incidents, diaries, journals, documents in general

• research outcomes are written using more flexible report styles with ‘lay’ language, executive summaries, action points

Knight also points out that there are a number of overlaps between the pragmatic and anti-positivist/anti-realist views.

In terms of our perception of reality he points out that ‘truth is situated’, in other words that the context determines the perception of what is true. This has resonances with the constructivist perspective on learning which is, as we have seen in Chapter 2, is also situated (Lave, 1998). The conception of reality has a bearing on the sampling methods that might be adopted. The harder approach believes that data samples can be generalised from, providing the data subjects are suitably/randomly selected in the first place, whereas the softer approach adopts the belief that reality being situated or local means that it is not possible to say samples are equivalent. This, of course, can cause problems for generalisablity, and the researcher needs to demonstrate further rigour in arguing from the specific to the general.

On the relationship between action and practice, Knight points out that these two aspects are combined, as proposed by Dewey. Once again we can see a resonance between a research perspective and the teaching and learning process. There is a continual interplay between knowledge and action so as we go about something we also change what we are aiming for. As will
be seen in later chapters, this is what happened, as expected, in the adoption of the action research approach in this study.

As was seen in Chapter 1, the main research aim of this study is to develop a model for ICT-enhanced teaching in PISE by asking the primary research question:

*Can the use of ICT enhance the learning experience of students working collaboratively in the domain of PISE?*

This research question assumes that it can but in order to answer the question changes must be made to the existing learning environment. As, as Knight (2002) says ‘to change the world through research’, even though the ‘world’ in this study is a specific learning environment in a specific domain. In other words, the research is not neutral. Therefore, the research methods used also connect with the underlying ontology and epistemology.

In deciding on the most appropriate research paradigm to adopt in this study, I confronted these philosophical issues surrounding our perception of reality and our resulting research paradigms. The nature of the study and the manner in which it was to be carried out indicated that the positivist perspective was not appropriate. The philosophical concepts underpinning the pragmatic/anti-positivist perspective did seem intuitively more appropriate but it was necessary to find a research framework which could encompass this approach. A review of the research literature lead to the discovery of the action research paradigm which is discussed in the following section.

A final reason for the inclination to the pragmatic/anti-positivist research perspective is the potential subjectivity of the researcher, which might affect the observer-dependent outcomes. In this study the aim is to develop and use an ICT-enhanced learning environment to ascertain if a group-based (and collaborative) approach enhance learning in PISE. But as the researcher is also the tutor on this module, and the assessor of the students, subjective attitudes as to what constitutes successful learning outcomes could compromise the analysis and interpretation of data.
In this section the difference between three perspectives for the selection of research methods have been investigated. The relationship between ontological and epistemological perspectives and research methods has been looked at and an argument as to why the pragmatic/anti-positivist research perspective has been adopted in this study has been put forward. Action research has been suggested as an encompassing framework that is firmly founded on these philosophical perspectives.

Sankaran et al (2007) say ‘action research is a pragmatic exercise about what methods one might use for the collection and analysis of data that will have usefulness’” As my primary aim is to develop a learning environment that will be of benefit to my students, as well as undertaking research, the data I collect and analyse has to be useful to enable me to develop this environment. In the next section I examine action research.

### 3.3 Action Research

In this section action research will be examined. The main features of this research approach will be explored and how they are particularly suitable for educational research in general and this study in particular will be examined.

#### 3.3.1 What is action research?

Reason and Bradbury (2001) propose that action research:

> seeks to bring together action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions to issues of pressing concern to people, and more generally the flourishing of individual persons and their communities.

In this definition we can see some core themes.

Firstly action research is about action and reflection. In this case it is critical reflection on the action taken by the researcher. Secondly it is a methodology that links research theory and context and does this by involving all stakeholders in the process. It is not ‘top down’ where some decide and others do. As Dick (2002) has said, ‘it removes the gap between the deciders and doers’. The third
core theme of the Reason et al (ibid) definition is the use of action research to bring about positive change in social contexts. This is a recent re-stating of action research as originally proposed.

Burns (1991) states that action research is ‘the application of fact finding to practical problem solving in a social situation with a view to improving the quality of action within it.’ It is therefore a method in which a condition is identified and then reactive action is planned and implemented whilst observing the effects of the action taken.

Dick (2002) defines action research as

\[ \text{a flexible spiral process which allows action (change, improvement) and research (understanding, knowledge) to be achieved at the same time. The understanding allows more informed change and at the same time is informed by that change. People affected by the change are usually involved in the action research.} \]

In this definition the spiral process is referred to as the link between research and action. As with the Reason et al definition there is also reference to involvement of the participants in the research process.

Action research is credited to Kurt Lewin who wrote in 1946:

\[ \text{The research needed for social practice can best be characterized as research for social management or social engineering. It is a type of action-research, a comparative research on the conditions and effects of various forms of social action, and research leading to social action.} \]

Lewin was a social psychologist and was particularly interested in helping disadvantaged groups in society to improve their economic situation through improved housing, employment, equality of race and gender and educational opportunity. He hoped that an outcome of this research methodology would be to improve independence amongst a social group involved in the research by reducing social exploitation. As such, this methodology was much more than being about theory making. It was about changing society.

Carr et al (1986) suggest that Lewin’s conception of action research was:

\[ \text{a form of self-reflective enquiry undertaken by participants in social situations in order to improve the rationality and justice of their own practices, their understanding of these practices, and the situations in which the practices are carried out} \]
Lewin’s central theme of a collaborative research approach involving all members of a community with the objective of beneficial change for all members of that community also became a central research perspective for many others. It was adopted as a methodology in many countries to promote social justice, civil rights and democracy (Brydon-Miller et al, 2003). It was also used in a wide range of contexts from private sector companies to public sector authorities. As Brydon-Miller et al state regarding the wide range of contexts in which action research has been used:

*what links them is the key question of how we go about generating knowledge that is both valid and vital to the well-being of individuals, communities, and for the promotion of larger-scale democratic social change*

This is also echoed by Bogdan et al (1992) when they say that action research is ‘the systematic collection of information that is designed to bring about social change’.

Action research is also strongly linked to the constructivist perspective. As Brydon-Miller et al point out, ‘action researchers embrace the notion of knowledge as socially constructed’ while at the same time rejecting that knowledge must be objective and value free if it is to remain credible, thus positioning action research on the anti-positivist part of the ontological/epistemological continuum.

### 3.3.2 Action research for social change, the link with Habermas and critical theory

A common theme among these definitions is that action research has a role in bringing about changes in society for the better. Critical theory (Habermas, 1972) has been suggested as being a theoretical basis for action research as it also is the basis for research methodologies that are designed to influence and change society for the better.

Critical theory is most often associated with Jurgen Habermas and other analysts in what was known as the Frankfurt School. These analysts were interested in ‘people being in cultural, economic and political control of their lives’ (Tripp, 1992). Although critical theory is associated with Habermas, it should be noted that the action research predates Habermas.

The Stanford Encyclopedia of Philosophy definition also supports the idea that critical theory is
often used to support the standpoint that research is not neutral:

it must explain what is wrong with current social reality, identify the actors to change it, and provide both clear norms for criticism and achievable practical goals for social transformation

And thus further shows the relationship with action research.

Kemmis and McTaggert (1990) also support the suggestion that Habermas has provided a theoretical background to action research methodology. However, Kemmis et al point out that there is considerable '...debate about the extent to which action research is a research methodology or technique on one hand or a broad approach to social research and reform on the other'. But that debate is beyond the scope of this study. However, many researchers have used action research as a useful and effective methodology that works well for what might be termed 'interventionist' types of research, that is research that changes some social situations.

Kemmis et al also raise the issue of where action research should be located, either as ‘…part of the wider field of social theory or in the narrower focus of education and the development of educational theory.' They point out that this can readily be seen by the different schools of action research, where some are concerned with '...the development of teacher's (or others') theories of education and society versus questions of social and educational change -- improvement, reform and innovation'.

In this study, action research is situated in the educational context.

Tripp (1990a) prefers the term socially-critical theory to the Frankfurt School term. He argues that as there are many ways of being critical it is more sensible to use the term socially-critical as it emphasises the social nature of this type of research. He also makes the point that critical theory as applied to educational research is:

informed by principles of social justice, both in terms of its own ways of working and in terms of its outcomes in and orientation to the community. It involves strategic pedagogic action on the part of classroom teachers, aimed at emancipation from overt and covert forms of domination. In practical terms, it is not simply a matter of challenging the existing practices of the system, but of seeking to understand what makes the system be the way it is, and challenging that, whilst remaining conscious that one's own sense of justice and equality are themselves open to question.
In this study a socially-critical theoretical approach underpins the methodology. The domain is Professional Issues, in particular computer ethics. It is a basic tenet of all ethical beliefs that to behave ethically is a socially just way of behaving. Socially-critical theory, as Tripp points out, is 'aimed at emancipation from overt and covert forms of domination'. A ‘strategic pedagogic action’ that allows this to occur is in keeping with this socially-critical theory. In terms of this research, therefore, a pedagogic method should be developed in which I do not tell students what is ethical behaviour, just as I am not told what is ethical behaviour by others.

This idea of the rejection of domination is also supported, as will be seen in Chapter 6, by Kohlberg (1964, 1984) and his hierarchy of moral reasoning. He argued that higher levels of moral reasoning demonstrated that people are free to make their own moral decisions based on ethical principles. Whereas lower, or less mature moral reasoning is based on what some authority has deemed to be the ethically correct way to behave. In other words, in trying to enhance the learning environment so that it raises moral reasoning ability in my students, ‘making them free from overt and covert forms of domination’, I am attempting not only to change the educational environment but to apply socially-critical theory so my students benefit. This ‘strategic pedagogic action’ is in keeping with socially critical theory. Using a research methodology based on this theoretical background is therefore appropriate to this research.

A theme emerging from the previous paragraphs indicates that action research, while being defined by some as a research methodology, is in fact more than this. It is also a vehicle for social change, and it is the changes that take place and their impact on the social context that provides the research context.

In this research study the social context is the learning environment; a context that it was considered needed to be changed in order to enhance the teaching and learning process. How to achieve this enhancement was on the one hand the subject of the research, but on the other was also the
consequence of this study. Thus the action research paradigm was further deemed appropriate when considered in this context.

3.3.3 Features of action research

As was mentioned previously, Kurt Lewin is considered to be one of the founding fathers of action research, if not the proposer of this methodology. The main contribution by Lewin (1946) was to suggest that the mode of inquiry was cyclical and comprised of analysis, fact-finding, conceptualisation, planning, implementation and evaluation. This is illustrated in Figure 3.2 below. Lewin also suggested that the push for inquiry should come from, and reside in, the problems of a particular social group and that group members should fully partake in the research process.

Figure 3.2 Lewin’s spiral of action research
Lewin described the cycle as follows:

*The first step then is to examine the idea carefully in the light of the means available. Frequently more fact-finding about the situation is required. If this first period of planning is successful, two items emerge: namely, “an overall plan” of how to reach the objective and secondly, a decision in regard to the first step of action. Usually this planning has also somewhat modified the original idea.*

He went on to describe the following stages of the process as:

> composed of a circle of planning, executing, and reconnaissance or fact finding for the purpose of evaluating the results of the second step, and preparing the rational basis for planning the third step, and for perhaps modifying again the overall plan

There have been criticisms of Lewin’s model. Elliott (1991) has suggested that the model proposed by Lewin can lead the researcher into deciding the research problem too early and not allowing for it to develop ‘iteratively’. Others, as we have seen, have suggested that action research is not a methodology at all but is a philosophy or way of thinking.

Some critics of action research have questioned the rigour of this approach to research. On the issue of rigour, Bogdan and Biklen (1992) point out that research is ‘a perspective that people take toward objects and activities’ and is therefore based on the view of knowledge and reality of the researcher. So long as the researcher in action research demonstrates rigour in the collection and analysis of data, and that ‘claimsmaking’ satisfied the accepted standards of rigour, then action research can refute these criticisms.

Dick (1993) and Winter (1989) consider a rigorous approach to involve a ‘dialectic’ as an effective method in achieving trustworthiness in action research data gathering and analysis. They suggest that this approach enables the researcher to see the research context from a variety of perspectives or viewpoints. Although similar to triangulation, it has in recent times being suggested it is closer to *crystallisation* (Richardson, 2000), which he suggests ‘provides us with a deepened, complex, thoroughly partial, understanding of the topic’.

Dick (2002) also points out that action research is acceptable as a rigorous methodology if there are brief and multiple action research cycles which can be achieved by having cycles within cycles with
the researcher tracking multiple data sources. Any two or more sources can then be used in this dialect or crystallisation process.

The phases within each of the main cycles of this study acted as mini cycles, each connecting to subsequent phases in successive cycles. It was as though the strands of the cycles were themselves woven with smaller strands or plaits. This allowed many more opportunities for critical reflection as the research process unfolded. This was the process carried out by this researcher.

Dick proposes a fairly simple model of the action research spiral as shown in Figure 3.3 below. Essentially this shows ‘action alternating with critical reflection’ (Dick 1998).

![Figure 3.3 Dick’s simple action research spiral](image)

However, critical reflection allows the researcher to ask what worked, what didn’t, what have I learned? And provided these questions are asked in a systematic way, Dick suggests three further reasons as to how action research is rigorous:

- By the involvement of all interested parties, which therefore provides more information about the research context.
- Critical reflection in each cycle provides the researcher with many opportunities to correct errors, especially when there are ‘cycles within cycles within cycles’, providing the researcher also is vigorous in searching for ‘disconfirming’ evidence.
- Theoretical assumptions underpinning the research context are tested in action within each cycle.

This then allows action research to be both rigorous while at the same time being flexible.
Action research is flexible because the cyclic process allows the researcher to start the process without a rigidly, a detailed designed study or pre-formed theoretical conceptions which are to be proved. With action research the design can be refined through the various cycles. The use of qualitative research methods also helps in this refining process. As will be seen later in this chapter, qualitative research methods allow for the investigation of vaguely formed research questions as part of the process of honing or refining the research context.

The following diagram shows a further development in Dick’s model.

![Diagram of action research cycles](image)

**Figure 3.4 Expansion of the critical review stage of action research.**

In Figure 3.4 above the critical reflection stage has been expanded to show the processes of critical review and the planning stage. So the outcome of the critical review process guides the researcher in the informed planning of subsequent cycles of research. This then allows the action researcher to provide changes to correct errors, refine imprecise research questions by using answers from earlier cycles to plan further cycles, and to test emerging theories by further action. As Dick (2002) says ‘action research [is defined] as beginning with fuzzy questions … all that is required is that with each cycle they become more precise’.

Action research is described by Carr and Kemmis (1993) as ‘research into one's own practice’ that has a typical research cycle involving four main components:

- planning
- action
The output from the reflection stage results in input to the next cycle of the research. However, Carr et al assert that these stages must be combined so that one stage informs the next, and information from one stage influences and shapes not only the next stage, but also, potentially, the shape of the whole cycle. Constant referral, alteration and adaptation are vital if action research is to be meaningful and useful (Bell, 1998).

Zuber-Skerritt (1982) has suggested that action research has certain distinctive features. The nature of the research inquiry is collaborative and is conducted by reflective practitioners. The aim of these researcher/practitioners is to be self-evaluative in their practice, to engage in participative problem solving and to make the results of their research public, thus informing theoretical development.

Although this description of action research is based in the educational context, it could apply to any social research involving communities or practitioners in any field. Again, we can see the themes of collaboration and desire to instigate positive change, but also the requirement to inform and engage with the wider research and practitioner community so that all can benefit from any research findings.

Finally, Dick (1999) has also suggested that action research, regardless of its research context, has six characteristics:

- **Change oriented**: the focus of action research is to bring about an improving change in a person or social system.
- **Action oriented**: relating this to the above, change is the result of action taken.
- **Cyclic**: each action is preceded by informed planning and followed by critical reflection which occur within cycles of research/action.
• **Data-based:** decisions about what actions to take in each cycle are based on data or information gathered in previous cycles.

• **Emergent:** the action research process is one where answers, and further research questions emerge from each cycle.

• **Participative:** those who are most affected by the change are involved in the process.

Having discussed some of the essential feature of the action research methodology, the next section will focus on the use of this approach in the educational context.

### 3.3.4 Educational Action Research

The action research methodology was not originally defined by Lewin (1946) as having an educational context and a review of the literature on action research shows a wide range of domains where this methodology has been used. Dick (2006) a range of areas including community applications, participatory development, human services and health care applications, organizational applications, appreciative inquiry, professional and practice development. Cohen et al, (2000) point out that action research is an appropriate methodology wherever there is an issue concerning people and where the solution is a favourable change in a society or organisation. Action research has also been successfully used in the fields of organisational and community development, work/life research.

One of the earliest uses of action research in an educational context was the work done by Stephen Corey (Corey, 1953) and colleagues at the Teachers College, Columbia University. Corey encouraged teachers, school principals and managers to use action research in improving their own practice and defined action research as ‘the process through which practitioners study their own practice to solve their personal practical problems’.

From an historical perspective we also find that there is also debate as to the origins of action research, with some arguing that long before Lewin the concept was suggested specifically for the educational field.
Burns (1999), amongst others, assert that action research was in fact suggested in the writings of John Dewey perhaps 20 years before Lewin. The following quote from Dewey (1929, cited Burns, 1999) is often cited to support this assertion:

*The answer is that (1) educational practices provide the data, the subject-matter, which form the problems of inquiry... These educational practices are also (2) the final test of value of the conclusions of all researches... Actual activities in education test the worth of scientific results... They may be scientific in some other field, but not in education until they serve educational purposes, and whether they really serve or not can be found out only in practice*

So although the provenance of action research is debated it is generally agreed that it has particular appropriateness as an educational research methodology. In fact many researchers (Elliott, 1998, Kemmis, 2001, Winter, 1996) in the field of educational transformation believe action research to be an apposite methodology for creating change because of its cyclical approach to problem detection, planning and action and its support for collaboration among all stakeholders in the research process. In others words, action research is a suitable methodology for this study, which is about the enhancement of the learning environment using feedback from all stakeholders to determine change.

Many researchers (e.g. McNiff and Whitehead, 2002, Winter, 1996) assert that action research is particularly useful for investigating professional practice because it ‘links researchers and research participants into a single community of interested colleagues’ (Winter, 1996) with the aim of creating practical knowledge that will improve the educational environment. McNaughton (1996) also argues that a central aim of educational action research is to generate knowledge that is practical, strategic and that has a function of uncovering ideological distortions and structural constraints to change. This is certainly one of the surprising outcomes that occurred in this study as will be discussed later.

Kemmis and McTaggart, (1982) believe that:

*Action Research can be defined as a combination of the terms ‘action’ and ‘research.’ Action research puts ideas into practice for the purpose of self-improvement and increasing knowledge about curriculum, teaching, and learning. The ultimate result is improvement in what happens in the classroom and school*
In the foregoing definition we can see that although this description includes a reference to improving social situations the context is firmly one of an educational environment.

Harmer (2002) focuses on the needs of the teacher when she suggests that action research is:

*a series of procedures teachers can engage in either because they wish to improve aspects of their teaching, or because they wish to evaluate the success and/or appropriateness of certain activities and procedures*

And Mills (2003) shifts the focus to include the needs of the student when he says:

*Action research is any systematic inquiry conducted by teacher researchers to gather information about the ways that their particular school operates, how they teach, and how well their students learn. The information is gathered with the goals of gaining insight, developing reflective practice, effecting positive changes in the school environment and on educational practices in general, and improving student outcomes.*

Finally McNiff and Whitehead again highlight the reflective aspect of action research in their definition: ‘Action research involves learning in and through action and reflection’. They go on to argue that action research, regardless of the context in which it is used, is ‘always to do with learning, and as learning is to do with education and growth, many people regard it (action research) as a form of educational research’

As can be seen from the foregoing section a common theme in defining educational action research is that it is focussed on the learning environment and the idea of improving or developing positive changes in this environment by critically reflecting on practice, and using the outcomes of this process to feed back into another cycle of research and reflection. But, some have argued that this professional practice is how good teachers should behave anyway. In the next section the difference between ‘good’ teaching practice and educational action research will be considered further.

### 3.3.5 Action research or just a conscientious teacher?
A fundamental premise of action research is that its initial impetus is the recognition that a problem exists in a group, community or organisation. From the educational perspective this also includes a college, department or even an individual course or unit and those who make up the group, the learners and the teacher or tutor. It may also need to include the teaching assistants, technicians or
other support personnel. So, in the situation where students are not achieving as much as is expected, it might be considered that the investigation of this ‘problem’ and possible solution is action research. But a ‘good’ teacher should always be investigating ways of improving her/his practice. So how is action research different from everyday professional behaviour of the good teachers?

Kemmis et al 1982, cited in McPherson and Nunes 2004, have identified four distinguishing factors between action research and professional self-reflection, which, they argue, distinguishes action research from everyday practice:

- action research is more systematic and collaborative in collecting evidence on which is based rigorous group reflection than are everyday responses to teaching/learning needs
- action research does not start from the point of having ‘problems’ to solve. It is more about possible problems (research questions) than just trying to solve problems and is motivated by a desire to make some improving change in the world
- research is not carried out on subjects or other people, action research is undertaken by practitioners on themselves and their own professional practice. It is about improving what is done.
- action research is more that just the application of the ‘scientific method’ to teaching practice

McPherson and Nunes (2004) also differentiate action research from ordinary teaching practice by making the point that educational action research is ‘a systematic process in which educationalists act deliberately on the basis of self-criticism and analysis’ and uses the systematic collection and analysis of data in the form of feedback from those involved in the educational environment to theorise about practice and ‘develop solutions, strategies and new questions’ This feedback is collected through participative research, both during and after the learning cycles, and from all participants in the learning process to implement solutions after reflecting on this feedback. The feedback is used to develop solutions and also to identify new research questions that need investigating.
The central purpose of action research is to develop an understanding of the situation, identification of the problem space and the development of a solution or solutions to the problem. Stringer (1990) suggests that action research has a number of characteristics that determine how the process of inquiry is undertaken. These are that it is:

- democratic, enabling the participation of all people.
- equitable, acknowledging people’s equality of worth.
- liberating, providing freedom from oppressive, debilitating conditions.
- life enhancing, enabling the expression of people’s full human potential.

Thus action research is always carried out through an explicit set of social values. In the context of an educational setting the views of students should not be ignored and should be considered as being as important as those of teachers/researchers. There should be full participation of all stakeholders, unlike the positivist approach, where the researcher is an objective uninvolved participant, recording findings from a ‘lofty’ perspective. Or the teacher sees a problem of student under achievement as being the student’s problem.

Students and learners who would previously have been designated subjects of educational research should, with this model, be participants in the process which should be applied to benefit all participants. The teacher/researcher as ‘font of all knowledge’ approach is dumped and the learner’s own worth is valued in the action research approach giving, as McPherson et al (2004) state, ‘a participative democratic ideal that achieves knowledge generation through learning from action’

McPherson et al also argue that action research is particularly suitable for education research because it is ‘a flexible, situationally responsive methodology that offers rigour, authenticity and voice to educationalists, practitioners and students’. So action research has the flexibility to accommodate changing circumstances that can arise during the research cycle. Action research is also designed to be an effective research method for the particular situation in which it is used, while at the same time making generalisable and verifiable claims. These claims can then be used to
support proposals that advance educational practice theory and can also suggest improvement in the teaching and learning process for teachers and students. And in this way it is also differentiated from normal teacher practice.

In conclusion, action research is different from good teaching practice because action research:

- makes a valid contribution to the entire education community by the development of theory as well as individual practice
- enables the questioning of standard approaches to teaching and learning – it challenges the status quo so that improvement in the domain can take place
- addresses the needs of many in the education environment, not just those of the practitioner, through the cycle of plan/reflect/act. It is a community approach not an individual one.
- promotes cooperation among all stakeholders and looks to improve the experience of all, not just that of the teacher.

In this section the difference between action research and good teaching practice has been examined. Some significant differences have been listed to show that action research is much more than just ‘good teaching’ practice although there are some overlaps, as Wolfe (1989) cited by Johnson (1993) states ‘teachers often leave a mark on their student, but they seldom leave a mark on their profession.’ Action research enables a mark to be also left on the profession.

As this is a hoped for outcome from this study, once again action research is identified as the most appropriate research methodology to be used.

In the next section some specific features of educational action research will be discussed.

3.3.6 Action research for educational informatics

When discussing the application of the action research methodology used in this study we have so far examined definitions of action research and looked at how it has been used in the educational context. However, the educational context is potentially very wide and can include different levels from primary to fourth (postgraduate) level. The context can also include a wide range of
environments from classrooms to labs and the use of different technologies to enhance the environment. In some cases these technologies may be the use of AV, audio systems for language learning or simulations for lab-based learning.

In this study the focus is on the use of ICT and in this section I will consider the roles of ICT in education, specifically educational informatics (EI) (Levy et al, 2003) and the use of action research methodology in researching EI. However, there are many ways in which ICT is used in learning, and in this section the focus will be on educational informatics.

ICT has been used in education almost since the initial development of computers. In the 1960s mainframe computers were used, with one of the earliest learning systems being PLATO developed by the US military. The development and use of ICT in learning paralleled the development of learning theories, Skinner’s behaviourist theories being the basis for programmed-learning machines. Later systems based on cognitive theories of learning and information processing included the use of artificial intelligence techniques to develop expert systems such as MYCIN for medical students and GUIDON for geology. Seymour Papert developed the computer programming language LOGO to enable users to construct shapes by writing programs to control a ‘turtle’, a small electric robot that held a pen and drew shapes on a board.

The development of the Internet and the ubiquity of access combined with the falling price of personal computers has introduced new ways of using ICT in learning environments. Access to learning materials now means that learners are not reliant on the teacher or library as the source of materials and can connect and communicate with resources, including other learners and teachers, from anywhere with Internet access. Of course, this has had consequences for plagiarism, which has been a sub-focus of this study which is discussed in Chapter 5.

The future of ICT also has much promise with the development of mobile computing, W2 and social networking being just some of the areas that are being looked at for their potential to enhance learning environments.
The following figure illustrates some of the main phases of the history of ICT in learning.

Figure 3.5 Phases of use of ICT in learning (Leinonen, 2005)

Levy et al (2003) have pointed out that there are a number of definitions for informatics and that these depend on the context. For computer science, informatics generally refers to issues related to ‘representations, processing and communication of information within computational systems’ but in information sciences there is a focus of interest on the ‘semantics of digital information use and communication’. Here we find that the content and context of information is of interest to researchers as well as the interactions between ‘multiple information sources’. Kling and Hara, cited in Levy, assert that informatics researchers in different domains tend to focus on the application of ICT and information management practices specific to the domain. But they also argue that there is a need to understand the consequences of the application of ICT on the users, not just the way applications are used.

Educational informatics is one such, and fairly new, domain of interest. Levy et al define educational informatics (EI) as ‘the study of the application of digital technologies and techniques to the use and communication of information in learning and education’. The authors also state that the main purpose of research context is the development and evaluation of ‘concepts, models, theories and techniques and methodologies’ relevant to the use of ICT in the learning environment.

There are two main issues of interest to EI researchers according to Levy et al. The first is the understanding of the effects on the users of ICTs in the teaching and learning process. The second
issue is the contribution to the development of practical knowledge concerning pedagogies, strategies for the use of ICT as well as research into systems and environments.

Furthermore Levy and her co-authors suggest that the key research interests in EI should include the design, use, implementation and evaluation of the outcomes of using ICT in the teaching and learning environment and ‘consider that action research …offers a valuable approach to improving practice and building practical knowledge in this domain’.

The research foci identified by Levy et al and the research methodology suggested, action research, are coincidental with this study. This gives further support to the action research methodological framework that I have. As Levy et al put it:

> the pedagogic model was developed with reference to constructivist perspectives on learning and the findings of previous action research with the aim of supporting self-managed, collaborative learning within a ‘virtual’ learning community, by means of on-line discussion, group-work and work-based projects’

which could almost have been written to describe some of the research cycles in this study.

3.3.7 Action research for online learning

McPherson et al point out that researchers ‘have focused on two main areas when implementing, delivering an evaluating online learning’:

- instructional design
- learner support systems and resource design

Resource design in this context does not just refer to learning materials but also includes ‘electronically mediated teaching and even group activities’ (QAA, 1999:21-2) cited in McPherson et al (2004). And they also assert that any action research model in the area of online learning development ‘must provide clear links to these two main areas’.

Tyler (1949) again cited in McPherson et al suggested the following principles in the approach to action research:

- defining appropriate learning objectives
• establishing useful learning experiences
• organising learning experiences to have a maximum cumulative effect
• evaluating curriculum and revising those aspects that did not prove to be effective

McPherson et al point out that Tyler’s model proposes a process that links to action research in the way different stages of the research are defined. The definition of learning objectives establishes hypotheses, pedagogies are developed in the establishment of learning experiences and how these are incorporated into the overall learning environment and finally the reflective element of action research is implied by the final point above on evaluation and revision. Although a criticism of Tyler’s model may be the obvious lack of reference to learner input this could easily be included by the expansion of the final point to include ‘by consideration of feedback from teachers AND learners’ as argued by McPherson et al.

3.3.8 Ethical issues with classroom based action research
As we have seen, action research provides a cyclical framework for research in an educational context. However, it is important not to lose sight of the fact that the learner is not there to be a subject of some research project, but to have the opportunity to do some learning. And it would be unethical to sublimate the learning experience for the purposes of research output.

Nolan et al (2007) point out that the potential for conflict in roles occurs when a teacher ‘is acting not only as a researcher but also as the change agent’ and that these conflicting roles can ‘confound the primary objective, student learning’. How then can these two potential conflicting activities be accommodated to avoid ethical issues educational action research?

This raises a number of questions.

• When does teaching become research?
• Where does the accountability for this research lie?
• Are teachers well enough trained to be able to see the ethical consequences in action research?
• How are the rights of the learner protected?

In any research involving human subjects it is common to allow individuals the right to opt out of the research process, but how can this be done if the process is the development of a pedagogical method? Can the learner really provide informed consent to a process that they may not yet have experienced in any case? If there is a blur between the research cycle and the introduction of novel pedagogic methods, how can the student make an informed decision as to whether or not to participate? As Nolan says ‘The teacher cannot abandon the role of practitioner but must always exercise professional judgment and skill in the best interest of the student’.

One suggestion to minimise the potential for ethical conflict, is to adopt a research approach that has similar characteristics to the teaching process that is being investigated. In this way the research and the pedagogical innovation coincide by having the same aim, the improvement of the learning experience. In this section I will discuss some recent theoretical proposals do just this.

Sankaran et al (2007) suggest the adoption of a **heutagological** approach to teaching and learning. Hase and Kenyon (2000) first coined the term **heutagogy** to express their belief that real learning takes place when learners exhibit self-determined learning. They were attempting to differentiate between learning on the one hand and the acquisition of knowledge and skills on the other.

Hase et al (2007) argue that action research is not just a set of techniques but is a way of thinking, and that action researchers share some common beliefs and features.

He proposes the idea that these features include:

• the ability to be flexible and open to experience

• a capacity to change and not to be rigid

• demonstrating egalitarianism

• a tendency to be participative and collaborative

• a questioning of the status quo
• a capacity to enjoy the process more than the outcomes

These are characteristics with which I certainly identified.

Hase et al continue that ‘…these characteristics suggest a predilection for learning in particular ways as suggested by people such as Kolb (1984) and Honey and Mumford (1982).’ They define it as a way of learning that is independent of the teacher and one that cannot be pre-determined.

The implications of this are twofold. Firstly although the world is now full of resources easily accessible to all learners, we as teachers spend an inordinate amount of time presenting these resources to our students when we should perhaps be more concerned with the learning process. And despite our best intentions in providing our students with comprehensive learning materials, more and more of them our finding their own learning resources on the Internet. We no longer, as teachers, need to spend so much time finding and passing on ‘content’ to our students. So the learner who learns from sources independent of the teacher is a heutagogic learner.

A second implication that follows on from this heutagogic approach to learning is the way teachers design learning experiences. Hase et al argue that these should be in the hands of the learner rather than controlled by the teacher. Heutagogy, then, places the learning experience firmly in the hands of the learner.

Action research, they also argue, is also a heutagogical process because the ‘learning is entirely in the hands of the participants’, and this learning is the result of critical reflection. The cyclical nature of action research confirms that we already have in the action research approach a similar process to heutagogical learning. In both cases necessary content is accessed as it is required, in response to the context, i.e. the reflective process.

So an approach to learning that is heutagogic is most appropriately investigated using a research methodology that is also heutagogical. And this is likely to minimise the potential for ethical conflict between classroom-based research and teaching, as mentioned previously.
This argument has resonances for this research. As will be seen later, the approach to learning developed throughout this study is heutagogical, even though the term was not suggested until recently. The heutagogic approach is perhaps best summed up by reference to the content-free nature of the ICT enhanced learning environment being investigated in this study. There are links to resources but these only amount to a small proportion of the resources available and used by the learners in PISE. Learners themselves find and use content as appropriate, often ignoring that which has been provided in preference to material they have found themselves. Nearly all of the content generated was as a result of the learning process that was in turn developed through the action research methodology.

So, action research is a heutagogic process and action researchers have a predisposition to be heutagogic learners and, as teachers, to also encourage the same learning approach in their students.

As Sankaran et al (2007) point out, action research appears
to approximate what we do as humans most days of our lives from cradle to grave. We experiment with the world, we gather information and experiment some more. We even pass our findings on to others and, if the receivers of this wisdom have any sense, they check it against their own reality.

i.e. we exhibit a heutagogic approach to learning.

3.3.9 **Action research in this study**
Action research has been examined in the previous sections and assertions made as to why it is suitable for use in an educational context. In this section the specific features of the action research approach will be focussed on.

From the outset, it was obvious that certain factors would have a bearing on the research methodology used in this study. For example, from an ethical perspective it is not acceptable to have some students in control groups whilst others are given access to learning environments that can enhance their learning. It is not justifiable that a specific group of learners can be denied the opportunity to reach their own potential because of the needs of a research study.
It was also obvious that changes to the pedagogic approaches adopted could only be implemented gradually. There was the need to convince colleagues of the desirability of spending scarce resources on hardware and software to support the introduction of ICT. There was the need to introduce new developing ICT systems over a period of years as these were rolled out. There was also the need to fully reflect on the outcomes of each pedagogic change before deciding to continue or abort the process. After all, the achievements of the learners is what was at stake, and related to the previous point, it would have been unethical, as well as being professionally questionable, to introduce pedagogic change if it was known to be detrimental to the learning environment.

These factors caused led to the investigation of research frameworks that would allow the combination of teaching and research to continue, thus hopefully improving the learning environment for the students, providing a research interest for the researcher and contributing to the body of knowledge on the use of certain pedagogic methods in third level learning in the 21st century.

Attendances at conferences to report early findings, literature research and contact with colleagues with similar interests led to the discovery of action research as a methodology. This then proved to be an appropriate research approach and one that could be justified.

The longitudinal nature of this study (it has so far taken nearly eight years), the need to introduce pedagogic change gradually so as to be sure student learning was not compromised, the beliefs of the researcher and the nature of the domain and research context all further contributed to the conclusion that action research was the most suitable methodology to use.

However, it does not necessarily follow that, as many writers assume, action research means using qualitative research methods for data gathering and analysis. In this study both qualitative research and quantitative research methods were used to create a dialectic and to crystallise research insights. In the next section these are discussed.
3.4 **Qualitative and quantitative methods for data collection and analysis**

In this section I discuss different methods for collecting and analysing data and the importance of deciding the best approach to adopt.

### 3.4.1 Claimsmaking

Knight (2002) uses the term ‘claimsmaking’ to refer to the process in research where assertions are made based on data collected and analysed. However, the way in which researchers undertake this process can be problematic. Central to these problems are the debates concerning the theory of gaining knowledge that is used and which data will provide the evidence for construction of knowledge.

Traditionally there are two ways of ‘knowing’ in research:

- Quantitative or hard/positivist/objectivist
- Qualitative or soft/anti positivist/interpretivist/naturalistic

Of late, and with some increasing frequency, a third approach is often adopted, that known as **mixed-method** which involves both of the above.

Action research, as we have seen previously, encompasses a wide spectrum of ontological perspectives. As a result action research methods include both qualitative and quantitative methods according to the needs of the particular study. In this study both techniques were used in different phases and in different cycles to confirm or disconfirm findings. Therefore in this section both qualitative and quantitative methods will be examined, as will approaches that mix both of these methods.

### 3.4.2 Qualitative research

Marshall et al (2006) suggest that qualitative research:

- takes place in the natural world
• uses multiple interactive, humanistic methods
• focuses on context
• is emergent rather than tightly configured
• is interpretive

They go on to argue that the qualitative researcher:
• has a holistic view of social phenomena
• reflects systematically on who she/he is in the research inquiry
• is aware of their own cultural background and how it influences the research
• uses multifaceted, iterative and reflective reasoning

Miles and Hubermann identify the following as among recurring characteristics of qualitative research:

• It is conducted through intense and prolonged contact with the ‘banal’ or ordinary lives of the individuals or groups.
• The role of the researcher is to gain an holistic view of the context.
• An ‘insider’ perspective is taken by the researcher so as to capture data through a process of deeply attentive and empathetic understanding.
• The researcher’s main aim is to elucidate how people comprehend, justify, initiate and handle their daily lives.
• There are relatively few standardised tools, the researcher is the main tool.
• Analysis is mainly done with words whereby the researcher can organise, arrange, dissect or gather into semiotic groupings to enable contrasts and comparisons to be drawn and some patterns identified or imparted.

However there are many criticisms of qualitative approaches. For example, it has been argued that qualitative methods are low on external validity, have a low level of control and a high possibility of researcher bias. This methodology can also be subjective because the researcher is the instrument of data collection, also interprets the data and is too close to the participants/subjects of the research.
It is also the case that all of these criticisms can also to some extent be aimed at quantitative researchers who after all may be designing the questionnaires from whence their quantitative data emanates.

Bodner (1992), in defending the use of qualitative methods in educational research, argues that in the wrong hands the quantitative paradigm can give rise to a ‘sports mentality’ approach to curriculum evaluation - limited comparisons of treatments and controls unreasonably removed from regular and possible classroom practice are statistically compared and victory or defeat for or against the innovation is declared.

and that the results of such research are more like ‘horse races’ and are not considered worthwhile by ‘working’ teachers. The main function of the quantitative method, Bodner asserts, is more to demonstrate control of the experimental situation by the researcher and less to improve the teaching and learning situation.

Essentially qualitative approaches describe a perspective where data may not be measured or counted objectively. To the qualitative researcher the context of the study is an important aspect. Qualitative methods are also interpretative and naturalistic.

Miles and Huberman (1994) suggest that qualitative research methods have particular strengths. They point out that these approaches focus on ‘naturally occurring, ordinary events in natural settings’. They identify ‘local groundedness’ whereby data is collected by the researcher close to the research context rather than using distance methods such as the post or phone. This emphasises ‘a focused and bounded phenomenon embedded in its context’ and in turn allows for a fuller understanding of the ‘influences and underlying non-obvious’ issues that can have an impact on the research study.

The richness and holism of the data also allows for the complexity of a context to be more fully revealed providing, a ‘thick’ description of what is going on. Furthermore, qualitative approaches often include longitudinal studies which provide much more than snapshots of the ‘what?’ or ‘how many’ type research questions.
Finally they suggest that qualitative research methods are fundamentally suited to investigating real meanings in people’s ‘lived experiences’.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus</td>
<td>Natural events in natural settings</td>
</tr>
<tr>
<td>Local groundedness</td>
<td>Researcher works close to research context</td>
</tr>
<tr>
<td>Holism</td>
<td>Thick description of complex situations</td>
</tr>
<tr>
<td>Timeframe</td>
<td>Longitudinal is more likely</td>
</tr>
<tr>
<td>Meanings</td>
<td>Real people and real meanings in ‘lived experiences’</td>
</tr>
</tbody>
</table>

Table 3.4.1 Summary of Miles and Huberman’s strengths of qualitative research

The qualitative researcher adopts an anti-positivist view of the world, as we have already seen. They also argue that it is not possible to fully understand human behaviour by adopting an objective perspective, instead the researcher needs to share the participants’ frames of reference, their interpretation of the world. It is extremely difficult, it is argued, to fully understand human behaviour by using exclusively numerical data.

### 3.4.3 Quantitative approaches

Quantitative approaches, on the other hand, adopt methods that are mainly based on statistical or other mathematical associations.

The methodologies grouped under the quantitative heading have primarily come from the natural sciences, and a problem might be that these methods cannot be totally successfully applied to social sciences. The ‘scientific’ method is objective and comes from the positivist perspective.

Kruger (2003) cites a number of advantages for quantitative approaches including:

- ability to facilitate a broader study, involving a greater number of subjects, and enhancing the generalisation of the results
- allows for greater objectivity and accuracy of results.
- are designed to provide summaries of data that support generalisations about the phenomenon under study.
• easy replication of research by using standard data collection and analysis

• avoidance of researcher personal bias by keeping a 'distance' from participating subjects, employing subjects unknown to researchers, and by using remote data collection such as questionnaires

However, quantitative approaches do benefit from the fact that the data is easy to analyse, and the precision given by the use of statistical analysis provided that assumptions of normality, randomness and independence of measurement are met.

Criticisms of the quantitative approach include:

• oversimplification of complex real world situation allowing data to lose some of its natural properties or meaning

• missing of some aspects that are not easily quantified

• an atomized approach instead of a holistic one

There have been, and probably in some circles continue to be, fierce battles as to which of the two aforementioned methods will provide better ways of knowing. As has already been seen, quantitative research is linked to positivism is criticized as being incommensurable with the naturalistic and interpretivist approaches. Qualitative researchers have in turn criticised their counterparts who use quantitative research methods as a ‘powerful establishment’ because funding often flows to this type of research, as we have already seen in the quote from Marshall et al (2006) at the beginning of this chapter.

3.4.4 Mixed methods
Instead of this dichotomy between qualitative and quantitative approaches, it has been suggested that it is better to address ways to make qualitative data more creditable, more neutral and more rigorous. As Miles et al (1994) say ‘we have to face the fact that numbers and words are both needed if we are to understand the world’.
A third approach to sensemaking, therefore, is the adoption of a ‘mixed methods’ perspective on the collection and analysis of data. The origins of this are said to be Campbell and Fiske (1959) who used both quantitative and qualitative research methods in their work. This has lead to a mixing of methods using qualitative approaches like observation and interviews and quantitative methods such as surveys and analysis. These can then be mixed in various ways. But why would a researcher wish to mix these different methods which are based on such different epistemological perspectives?

Miles et al (1994) believe that the qualitative/quantitative research debate is largely unproductive. They cite the work of Howe (1985, 1988) who analysed many studies and as a result suggested that both methods are ‘inextricably intertwined’. They also continue to pose the questions, not whether both types of analysis should be used but rather how, when and for what reasons should a researcher use mixed methods approaches.

Rossman and Wilson (1984) point out three reasons why linking these methods can be beneficial. They argue that mixed methods approaches can:

• confirm and corroborate each other by ‘triangulation’
• help to develop and elaborate analysis of data by giving richer detail
• give new and deeper insight by focusing on paradoxes and interesting results

Greene et al (1982), cited in Miles et al (1994), suggest that researchers should link both methods to enable the results of one method to be used to inform the second method’s sampling, and can therefore extend the scope of a study by using the different approaches in different phases of the research.

Firestone (1987), also cited in Miles et al (1994), argues that quantitative research can help to play down individual judgments and enable results to be more generalisable. At the same time qualitative research can provide a ‘richer depiction’ of data and avoid the ‘abstraction inherent in quantitative studies’.
Other researchers (Dick, 2002, Richardson, 2000, Winter, 1989) as we saw earlier, have argued that an approach that uses multiple data sources can provide rigour in action research because of the dialectic or crystallisation of data. This allows the data to be confirmed or disconfirmed depending on the analyses. And there is no reason why the data gathering and analysis methods have to be entirely qualitative or quantitative methods.

Aspects of all of these arguments have aided the development of this study, especially as an action research methodology has been adopted. Both qualitative research and quantitative research methods have helped in designing successive cycles as the research proceeded.

There are a number of methods that can be used to link the different data collection and analysis methods and these can be varied according to the needs of the specific research study. Miles et al (1994) suggest the following four possibilities as shown in Figure 3.7 below.

Figure 3.6 Designs for linking qualitative research and quantitative research methods (from Miles and Huberman, 1994)

In the first design the data is collected and analysed in a steady integrated manner using both techniques as required.
The second design shows a multi-phase survey which is carried out in stages throughout the research study in parallel with the qualitative research. Each phase draws on and feeds into the qualitative research and the qualitative research develops the survey instrument for successive phases.

In designs number three and four above, both qualitative research and quantitative research data collection and analysis methods are alternated. With design three the research process starts with some exploratory fieldwork which helps the development of a quantitative instrument, the questionnaire. The findings produced by the questionnaire can be further examined and understanding deepened by further qualitative research methods such as focus groups and interviews.

Design four is where an initial quantitative research method such as a survey points the researcher in the direction of important phenomena or paradoxes which can be examined using, for example, interviews or observations to help the researcher develop a deeper conceptual understanding on the phenomena. This could lead to some hypotheses that can then be tested using quantitative research methods such as an experiment.

This linking can be particularly useful in action research as each cycle can adopt a particular methodology as appropriate and the results used to design successive cycles. In this study this was partially done, but within each cycle multiple strategies were also used. These are discussed in more detail in Chapters 5 to 7.

Miles et al (1994) suggest that there are three ways in which linking is beneficial:

- the ‘quantizing’ level where qualitative data can be counted or converted into scales
- linking data types – where comparisons are drawn between qualitative research data and quantitative data, for example between an interview and a questionnaire completed by the same participant.
- research study design – for example those illustrated in Figure 3.7 above
In this study it was primarily the second reason that persuaded me to adopt the mixed method approach.

3.5 Conclusion
This chapter linked the philosophical debate on the meanings of reality and definitions of knowledge to the research methodology used in this study. This led to a discussion of the methodologies that are appropriate for sensemaking and claimsmaking (Knight, 2002).

The chapter then examined a particular research methodology, action research, and discussed how this was appropriate for this study, especially as the research necessitated a number of iterations and also because the focus was on ‘educational informatics’.

Finally the way in which data is collected and analysed was discussed in the context of the philosophical position adopted by the researcher. This then led into the debate on which methods are most appropriate. Following a discussion on qualitative and quantitative methods a third approach was argued for, a mixed-method or triangulation. This is the type of claimsmaking used in this research to support the findings from the different iterations of the action research cycles.

The manner in which this methodology was applied is described in more detail in Chapters 5 to 7 where the cycles of research are more fully discussed.
4 Setting the Scene

4.1 Introduction

In this chapter I will introduce the background to the research study. I will look at the context that led to my initial interest in this research area and how this developed into an action research study and the forming of the primary research question:

*Can the use of ICT enhance the learning experience of students working collaboratively in the domain of PISE?*

I will then briefly outline the different cycles of action research that were undertaken and which are discussed in detail in the following chapters.

4.2 Context of the research

The impetus for this research study arose from my appointment as a lecturer at the University of Limerick. Previously I had been a teaching assistant (TA) on the PISE module. A TA’s duties mainly involved running tutorials and assisting with assessment. With this full-time post came the requirement to take over complete responsibility for the PISE module. As a new faculty member I was also required to undertake research. Both of these factors were to converge.

I had taught Professional Issue type courses previously in other colleges. However the cohort at UL was 130, much larger than anything I had previously faced. My past experience allowed group-based approaches to be used in the teaching and learning process with successful consequences. PISE at UL had originally only a small cohort, averaging around 25 to 30, and had been established with a commitment to a group-based pedagogy. However, the dramatic increase in student numbers in computer science courses in the 1990s changed the challenges to those teaching on these degree programmes, especially those that used a group-based approach. There were suggestions from colleagues and management that teaching methods may have to change to accommodate the larger cohorts. However, I firmly believed, and the literature supported such beliefs, that this group-based pedagogy was the most appropriate for this subject domain.
There were a number of issues associated with this module:

- teaching very large cohorts
- developments relating to course content in the CSIS degree and whether PISE should remain a core module or become an elective
- concerns about PISE raised by different stakeholders

These are discussed further below.

Further issues became apparent following my first year teaching PISE:

- Some students did not see the point of PISE because they failed to engage with the module. So how could I encourage involvement and engagement?
- Colleagues were concerned that I should be able to justify my teaching and assessment methods.
- Exam boards required me to be able to defend individual grades awarded. What material evidence needed to be gathered to enable me to do this? How could I discover what individual learners had achieved when using a group-based approach to teaching and assessment?
- External examiners wanted to ensure that the assessment methods were appropriate for final year and degree courses and were in line with other institutions. Could I justify the group-based approach?
- Appeals boards would require me to be able to justify grades if a student appealed. There would need to be some sort of evidence, normally a marked exam paper or audit trail of assessment instruments used. Could I produce this?

I therefore began to consider if I could develop a research study related to these issues while also addressing the specific problems that I faced as a lecturer in PISE with 120 students.

This then was the context in which this study was born.

4.3 Applying action research

As discussed in Chapter 3, Dick (2002) describes the early cycles of action research as the ‘fuzzy’ stages. He suggests that during these early cycles general research ideas are discovered, often
because of personal experience in a specific teaching context. This was the case with in this preliminary stage of the research.

Dick also suggests there may be some specific research tasks that need to be carried out as a result of the critical reflection in each phase of action research. I noted three specific tasks that I would need to continually adopt:

- the need to document and record what I did so I could reflect from year to year to avoid repeating mistakes and implement practices that showed positive results.
- the need to ensure regular updating of my personal journal.
- continuous review of the literature.

I adopted these methods to help create the analysis and critical reflection of this and succeeding research phases.

4.4 Initial problems

In my first year teaching PISE there were approximately 130 students. Students were assessed by a group-based presentation and a group-based written report. Individual grades were relatively easy to assess in the presentation as each group member presented their own work. It was more difficult when reading a report to confirm the level of individual contribution. Added to this was the requirement for lecturers to be able to defend the grades awarded when questioned by external examiners and others involved in quality assessment and inter-institutional moderation.

The first problem I encountered was in managing such a large cohort. This presented some immediate questions:

- How does one lecturer manage such a large cohort?
- How can a meaningful learning experience be had by the students in such large cohorts?
- How can I avoid ‘burn out’ while at the same time considering the needs of such a large body of students?

Informal discussions with colleagues at UL quickly identified that I was not alone in facing
problems with teaching large cohorts of students. There were also many references in the literature to such problems in third level education. The earliest I found, a study by Macomber and Siegel dated from 1957. Among the problems associated with large group teaching were:

- that student-lecturer contact and interaction is minimised
- lecturers cannot provide individual assistance to students so there could be large numbers of students who need help but cannot access it
- marking assignments rapidly poses problems for the lecturer in very large classes

The large cohort also caused considerable management difficulties. These included:

- organising students into groups
- allocating a topic to each group for their assignment, one not already chosen by another group
- selecting a subject for presentations
- choosing a tutorial slot that all group members could attend

My journal records the following entries which give a flavour of some of the problems I encountered.

... had almost 40 visits by students over the past week when setting up groups, choosing topics, presentation slots and tutorial times. All with similar concerns and questions. This was later followed by a spate of meetings with groups who did not like some of their members or the topics allocated (which was done by me because they had missed the deadline to do so themselves).

More student visits, much disgruntlement at module methods and content. ‘Why do we have to do this stuff?’ is a common question.

I was also concerned because of the projected increase in student numbers over the next few years. The Computer Science and Information Systems (CSIS) department was growing very quickly and the new first year intake (nearly 300) raised some worrying implications for teaching and assessment methods used in PISE. This level of intake would mean the cohort would grow to around 200.
4.5 Stakeholder concerns

As has already been seen a number of different stakeholders had been identified. Clearly one of the main stakeholders was the learner, but others included:

- the lecturer
- teaching assistant(s)
- department colleagues
- exam boards
- external examiners
- the UL Appeals Board

Each of these had views on PISE, the module content, the pedagogical methods used, the appropriateness of the assessment methods etc. I therefore needed to further develop arguments to support my beliefs on these points. I also needed to ensure that the assessment instruments I used could be defended to all stakeholders in the event of detailed examination. In other words there was an organisational context that also needed consideration.

These extracts from my journal refer to the concerns of the external examiners on the appropriateness of the group-based approach to assessment in PISE. These concerns could also have implications when exam boards met to consider student degree classification or if a student appealed the grade awarded in a module.

*External examiners’ report from last year questions the group-based assessment methods used and how individual grades are allocated based on this method. Can I be sure that the grades awarded to a group are an appropriate method of assessing each group member? Ongoing concern about this.*

*Externals specifically express concern about group-based assessment for final year students. They don’t like it! I need to identify a way of rewarding individual contribution to group work.*

The issue of individual grades raised further problems as illustrated by the following from my journal:
Some complaints from individuals who say they worked harder than other group members and should get more marks as a result. Other complaints about how poorly performing teams are negatively affecting marks for some individuals.

DS [student initials] being considered for 2:1 and it appears that a low mark in my module is stopping him from getting this award. I have been asked at exam board to consider if I am 100% happy about mark I gave. Not sure I can be this positive as he was member of a group that performed poorly in assignment. Especially in light of other student complaints about levels of work done and negative effect of group-work on individual grades.

Reflection on these issues helped to further develop and ‘harden’ the research foci. As a result a number of issues were identified for further investigation and a series of propositions and more focussed research themes was distilled.

4.6 Developments on course content in the CSIS degree
Because of changes being implemented by a new head of department (HoD) discussions started on the existing range of modules in the CSIS degree programme and which should be core and which should be elective. Each member of faculty had to produce justification for the modules they taught. This included PISE.

The following is an extract from my personal journal. It records my concerns about PISE being relegated to an elective module on our degree course as part of a restructuring proposal by the new HoD.

D (new HoD) wants to re-examine course content and consider new courses. Should PISE and Business Computing (BC) be core or should they be elective? JC [tutor for BC module] is pushing for BC to be core, I work as his TA. Not a lot of support for PISE I feel. Some colleagues argue that there are too many other CS subjects that need to be included in a degree programme.

My colleagues were not alone in their attitude that other subjects in this broad discipline also needed inclusion. This debate had already taken place in many other institutions and had lead to some accrediting bodies addressing this question. I therefore sought out support for my position.

I recorded my conversations with KR and LB who originally conceived PISE at UL and wrote the module description. I needed to determine their original bases for including this module in the CS curriculum. The following are extracts from my journal relating to these conversations.
Met with KR and LB. They set up PISE because it was felt necessary for a CS degree programme to have a module that focussed on these themes [Professional, legal ethical and social issues]. Also it was seen that other colleges had similar modules in their degree programmes. BCS and ACM and IEI all required such modules in their accredited programmes.

KR and LB had an interest in these topics and LB had published research on related issues.

KR has a personal belief in the importance of PISE, has relation who is involved in ethical issues for the IMO. Feels strongly that as computer professionals, our graduates have a duty to behave ethically, as well as legally and this module is necessary to introduce the students to these concepts.

Both have referred me to the work of ACM and their work on the computing curriculum I identified a significant body of research that supported the inclusions of PISE type modules in CS degree curricula (see Appendix 4.0). This research was produced and supported by many international professional bodies. These bodies would not give accreditation to a degree programme that omitted such a module. As a result of this research I was able to argue successfully with my colleagues for the continued inclusion of PISE as a mandatory core module in our CS degree. But importantly this process also allowed me to focus on the module content and increase my awareness of the appropriateness of what I was including.

4.7 Validation of content and pedagogy in PISE

The next issue I focussed on was the development of teaching and assessment methods in PISE. I needed to validate the content and pedagogy in PISE. I therefore began to consider the learning outcomes for this module. I needed to be able to answer the question ‘are students learning?’

To enable me to do this I needed to focus on some specific issues. These included:

- the relationship between learning and the development of higher-order critical thinking skills
- how these skills are related to the subject domain of PISE, especially to moral reasoning
- the relationship between higher-order critical thinking skills and learning outcomes
- identification of suitable content at the appropriate level
- development of pedagogical methods that aid the enhancement of critical thinking skills of learners in PISE
As was discussed in Chapter 2, the development of higher-order critical thinking skills is fundamental to a university education. Therefore it was necessary to identify learning activities that would enhance this development and also to establish an appropriate method to assess whether higher-order critical thinking skills were in fact being developed by students on this module.

My review of the research indicated that I needed to develop an appropriate pedagogical strategy to encourage higher-order critical thinking skills in my students. This would require teaching and assessment methods that gave learners the opportunity to achieve higher learning outcomes (Bloom, 1956, Anderson and Kratwohl, 2001). Pedagogies also had to focus on participative learning and problem-solving exercises, and use activities that encouraged peer-to-peer interaction.

I determined a body of knowledge to cover in PISE to achieve this including:

• an introduction to ethical theories
• how ethical theories could be applied in ethical decision making
• dialectic
• ethical decision-making frameworks

Although I had an assignment whereby students could be assessed on their learning achievements, I also needed to develop a series of opportunities for them to apply their learning and receive feedback before undertaking the assessed component. Tutorials offered such an opportunity.

I identified a series of small case study examples for use in class and tutorials. I arranged that some of the tutorials would be conducted in the form of ‘mini’ debates on ethical issues. Students were divided into two opposing groups and encouraged to identify the ethical dilemmas central to these case studies. They were then to debate different proposals based on the application of ethical theories.

Typical scenarios for these examples concerned plagiarism and the use of the Internet to help with assignments, illegal downloading of MP3 music files and software. I chose scenarios that were
pertinent to the students’ own experiences. The aims of these authentic learning exercises were to engage learners and to enable them to experience each of the stages of Anderson et al's (ibid) taxonomy (see Chapter 2) which is shown in Table 4.1 below. I also hoped to address one of my earlier concerns of making the module relevant to the learner.

<table>
<thead>
<tr>
<th>Remember</th>
<th>learn facts e.g. utilitarianism, Kantianism, virtue ethics, memorise a decision-making framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understand</td>
<td>e.g. what is the ethical dilemma, who are stakeholders?</td>
</tr>
<tr>
<td>Apply</td>
<td>go through case steps, apply the decision making framework</td>
</tr>
<tr>
<td>Analyse</td>
<td>consider causality assumptions etc.</td>
</tr>
<tr>
<td>Evaluate</td>
<td>dialectic, can the proposed solution be universalised?</td>
</tr>
<tr>
<td>Create</td>
<td>create a novel recommendation for ethical behaviour</td>
</tr>
</tbody>
</table>

Table 4.1 Anderson and Krathwohl’s taxonomy as applied to PISE.

By adopting a group-based approach it was intended that learners would be more likely to:

- analyse a moral dilemma
- evaluate different moral solutions
- apply their resulting solutions to deal with new ethical dilemmas

James Moore (1984) has pointed out that a policy vacuum often exists in the formulation of ethical solutions in the domain of information and computer technology. In some cases the existing ethical solutions we have will not suffice. For example, the Internet has produced new ethical dilemmas in relation to freedom of speech that no earlier medium created, and this has resulted in the creation of new ethical tools to analyse these dilemmas. The final two levels in the Anderson et al (ibid) taxonomy would be used to achieve this.

The Anderson et al (ibid) taxonomy reversed the order of the two highest learning outcome categories from that proposed by Bloom. But this re-ordering seemed more appropriate for PISE because of the nature of the domain and the issue of policy vacuums identified by Moore. These two levels also supported the group-based approach to teaching and learning in PISE.

The dialectic in ethical philosophy involves a process whereby an ethical claim is made and then instances are explored to see if the initial claim stands up. If not then the claim needs revising. For
example, the claim that all life is sacred is sometimes used to oppose abortion. But some anti-abortion opponents have killed doctors who have carried out abortions. This latter instance is inconsistent with the initial claim and therefore the dialectic requires the initial claim to be revisited and modified.

This process is more likely to be progressed in a dialogue than on one’s own. Therefore the dialectic requires that a group-based approach be used.

Similarly, the creation of ethical solutions to dilemmas is something that comes out of the group. Ethics are the result of societies or communities agreeing what is right or wrong. It is not an individual perspective even though the individual moral perspective decides whether or not to abide by the group ethic. And in determining what is an ethical perspective requires group negotiation and argument. This again points to the need for a group-based pedagogy when teaching and learning ethics.

Bloom’s Affective Domain (see Chapter 2) of learning outcomes also provided me with a useful framework to further define the content I was developing in PISE. It also provided a justification for the group-based pedagogy that was being used.

As was discussed in Chapter 2 there is a link between pedagogy and learning outcomes such that to get a student to the final three levels of the Affective Domain requires participative learning.

It became apparent from my analysis of feedback that this strategy was partially successful. Students would frequently respond to other learners’ views on an emotional level. This indicated to me that the higher categories of the Affective dimension were coming into play here. Learners were certainly moving beyond the receiving and responding levels in the debates as values were stated and defended in the tutorial discussions.

The following table indicates how I mapped Bloom’s five stages of Receiving, Responding, Valuing, Organization and Characterisation onto PISE.
<table>
<thead>
<tr>
<th>Stage</th>
<th>Student behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receiving</td>
<td>Receiving ideas and concepts in lectures and from a range of learning resources such as books, Internet web sites</td>
</tr>
<tr>
<td>Responding</td>
<td>In discussions and debates in class and in tutorials</td>
</tr>
<tr>
<td>Valuing</td>
<td>Relating ethical dilemmas to their personal behaviour, e.g. illegal downloading of MP3 files, using unlicensed copies of software. Becoming more aware of the importance to them of PISE.</td>
</tr>
<tr>
<td>Organisation</td>
<td>Internalisation of an ethical value system</td>
</tr>
<tr>
<td>Characterisation</td>
<td>Becoming a ‘moral’ or virtuous person as described by Aristotelian virtue ethics.</td>
</tr>
</tbody>
</table>

Table 4.2 Mapping Bloom’s five stage of Affective Domain learning outcomes onto PISE

The final stage, Characterisation, needs some explanation. I wanted the Character of my students to be affected by their engagement with PISE as this would also be indicative of higher-order thinking as proposed by Kohlberg (1964) and discussed more fully in Chapter 6. It was therefore necessary for students not just to know about ethics in software engineering but to develop ethical reasoning as a cognitive skill and for this to be melded into their characters. And this tied in with one particular ethical theory, Aristotle’s Virtue Ethics.

Aristotle (350BC) suggested that Virtues are attitudes, dispositions, or character traits that need to be developed in a moral person. In other words, the fundamental question of ethics is not ‘What should I do?’ but ‘What kind of person should I be?’ The Virtue Ethics approach focuses on virtues and sees how they contribute to the characteristics of a ‘good’ person (which, according to codes of ethics of the professional bodies, also apply to a computer professional). They will exhibit honesty in their dealings, courage in the face of pressure to act illegally, and so forth.

Aristotle also argued that the way to become a ‘good’ person is to learn about ethical behaviour then to practice it. PISE provided an environment where the learner could start this process.

Hursthouse (2007) also notes in relation to the virtue of honesty that:

> An honest person's reasons and choices with respect to honest and dishonest actions reflect her views about honesty and truth — but of course such views manifest themselves with respect to other actions, and to emotional reactions as well.

This in turn ties in with the emotional basis for the Affective domain as proposed by Bloom.
4.8 Developing major research themes for the study

The above mentioned issues of teaching large cohorts, stakeholder concerns and the process of validating the content and place of PISE in the CSIS degree contributed to my increasing conviction that this was indeed an area worthy of research. I now began to focus on specific research themes as suggested by Dick (2002). These helped identify the main thrust of the developing research study. I also reflected on research questions following the first cycle of teaching and assessing. Three such were specifically considered:

- How could I apply an appropriate pedagogy so that the module used the most effective teaching and assessment methods with large cohorts?
- Could I validate PISE to all stakeholders in terms of the group-based assessment methods used?

And following on from these:

- Could information and computer technology (ICT) help to enhance the learning environment for group-based approaches to teaching and assessment?

An overview of the existing research literature indicated that a relatively new type of computer-based tool for educational application called a Virtual Learning Environment (VLE) held some promise. But there was no evidence of this being used in my subject domain of PISE. I already had a long-running interest in the application of ICT to education and had previously completed a research MSc. in this area (Griffin 1998). It therefore seemed a natural extension of my research interest to include this final research question.

4.9 Overview of research themes and teaching cycles

Over the following eight years I conducted a series of action research cycles. Because I only taught PISE once per academic year I combined different research themes into each year. I have already shown the phases of action research in chapter 1. Table 4.3 below outlines the chronology of research and the link between the research themes and teaching cycles.
<table>
<thead>
<tr>
<th>Research theme/year</th>
<th>Partners</th>
<th>VLE used</th>
<th>Guidelines &amp; outputs produced</th>
<th>Research themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>None</td>
<td>Bb (free)</td>
<td>Guide to online discussions Version 1</td>
<td>Using ICT to support teaching large cohorts</td>
</tr>
<tr>
<td>2001</td>
<td>SHU</td>
<td>Bb (UL)</td>
<td>Guide to online discussions Version 2; Constraints Version 1</td>
<td>Online discussions for learning; Multi-institutional collaboration</td>
</tr>
<tr>
<td>2002</td>
<td>SHU &amp; DMU</td>
<td>Bb (UL)</td>
<td>Guide to online discussions Version 3; Constraints Version 2</td>
<td>Multi-institutional collaboration</td>
</tr>
<tr>
<td>2003</td>
<td>SHU &amp; DMU</td>
<td>Bb (UL)</td>
<td>Forming and sustaining groups Version 1</td>
<td>Multi-institutional collaboration; Measuring learning - MJT</td>
</tr>
<tr>
<td>2004</td>
<td>SHU &amp; DMU</td>
<td>Bb (UL)</td>
<td>Forming and sustaining groups Version 2</td>
<td>Multi-institutional collaboration; Measuring learning - MJT</td>
</tr>
<tr>
<td>2005</td>
<td>EL</td>
<td>Moodle</td>
<td>Forming and sustaining groups Version 3; CP framework Version 1</td>
<td>Multi-institutional collaboration; Measuring learning - MJT</td>
</tr>
<tr>
<td>2006</td>
<td>EL &amp; EHC</td>
<td>Moodle</td>
<td>CP framework Version 2</td>
<td>Measuring learning - CP; developing formative feedback mechanism</td>
</tr>
<tr>
<td>2007</td>
<td>EHC</td>
<td>Moodle</td>
<td>CP framework Version 3; DVReport guide</td>
<td>Data visualisation for formative feedback</td>
</tr>
<tr>
<td>2008</td>
<td>Malta</td>
<td>Moodle</td>
<td>CP framework Version 3; DVReport guide</td>
<td>Data visualisation for formative feedback</td>
</tr>
</tbody>
</table>

Table 4.3 Chronology of research

The Partners column shows the collaborating institutions who worked with me. These were:

- Sacred Heart University (SHU)
- De Montfort University (DMU)
- East London University
- Edgehill College, Lancaster University (EHC)
- University of Malta

I investigate and used two different virtual learning environments Blackboard (Bb) and Moodle.

The Bb VLE was initially provided by the Bb company as a free service on their own server. I subsequently installed a server at UL.

One of the central research issues was how to determine if learning was enhanced by the used of ICT to support group-based learning. I investigated a number of different methods and these are listed in the next column (and discussed in Chapter 6).
Outputs from the research included various guidelines (these are discussed in Chapter 6 and 7 following). Action research enabled me to develop these over a number of teaching cycles and these are listed in the next column with the version number shown where appropriate.

Each cycle of teaching involved different research themes and the action research methodology meant that each iteration produced feedback and/or other outputs. These are listed in the final column of the table. These were the basis for succeeding phases of research.

4.10 Conclusion
In this chapter I have discussed the context in which this research study was born and how I generated focussed research questions from a broad ‘fuzzy’ stage of action research. These preliminary research questions originated because I was confronted with some specific issues when I took over teaching the PISE module.

Reviews of the literature and discussions I had with colleagues helped to develop my knowledge of currently accepted views on a number of topics. I was also working to further develop personal theories and knowledge on the content and pedagogies for PISE.

Thus this preliminary stage of the research study prepared the ground for future cycles of research. It focussed a personal, professional practice problem into a more general pedagogic problem which might contribute to more widespread theories of teaching and learning. In other words it moved from being a personal professional problem to being a research problem.

My research had also indicated that ICT tools could be used to support teaching and assessing large cohorts, and could contribute to enhancing the learning process and development of higher-order critical thinking skills. I was thus able, at the end of this preliminary cycle of research, to combine the different research themes into a single research question. Future action research cycles investigated different aspects of the research question over an eight year period. These are discussed in the following three chapters.
5 Getting down to work

5 Personal narrative on Cycle 1

The context to this research, discussed in the previous chapter, generated the fundamental research question of this study:

*Can the use of ICT enhance the learning experience of students working collaboratively in the domain of PISE?*

I felt that the issues discussed in the previous chapter could possibly be helped by using ICT to support the teaching and learning process. My next step, therefore, was to investigate the potential for using ICT in PISE, i.e. getting down to work on the core research question.

This cycle of the action research focussed on the following different themes:

- identifying the most suitable type of ICT
- using ICT to support teaching and learning in PISE
- identifying a suitable partner for collaboration
- multi-institutional collaboration in teaching and learning in PISE

The following diagram shows the phases of this cycle of action research.

Figure 5.1 Phases of Cycle 1.
The first phase discusses the selection of the ICT. Phase 2 examines the initial use of the ICT with students from one institution. The third phase focuses on the very important issue of finding a suitable collaboration partner for multi-institutional collaboration. Phases 4 and 5 focus on the multi-institutional collaborations. Following this personal narrative the reader can either move directly to the next chapter to continue the narrative or read the remainder of this chapter.

The chapter continues with a justification from the literature of research related to the phases in this cycle. Finally the chapter concludes with a critical reflection on multi-institutional collaboration.

As was previously discussed, the action research model involves not only doing research, but sharing research outcomes with others in the field. This enables a researcher to get feedback and to have the results critically evaluated by colleagues. I presented conference papers on the research in this cycle (Griffin et al, 2002a, 2002b) so that I could get this feedback. These papers are the basis of the phases of this cycle of research.

5.1.1 Phase 1.1 Selecting the ICT

5.1.1.1 Overview
As was seen the Literature Review in Chapter 2, there is a body of research that supports the group-based approach as a useful pedagogy in courses such as PISE. This also tied in with my constructivist approach to the teaching and learning process.

Therefore, in order to overcome the problems associated with managing larger cohorts and to ensure that the advantages of group-based learning were continued, my focus in this phase was to identify a suitable tool.

5.1.1.2 Research Methods and data gathering
There were two main questions that needed answering in this phase:

1. What tools existed.

2. Were they suited to my proposed pedagogy?
The research methods and data gathering processes I adopted during this phase were:

- review of the literature
- analysis of the functional requirements of group-based learning and assessment
- systems benchmarking
- investigation of tools and functionality of different ICTs
- review of existing ICT-supported courses

I also set about adapting a functional benchmarking process to use in identifying the most appropriate ICT for PISE.

5.1.1.3 Analysis of data and critical reflection

My research of the literature identified tools that had been developed as a result of research in computer-supported cooperative work (CSCW). These tools had functionality that allowed geographically dispersed teams to work online on common projects. As far back as 1993, Laurillard had identified the potential for use of CSCW in education. Her research and that of others is further discussed in section 5.2 below.

I discovered that a family of ICT called Virtual Learning Environments (VLE) were being developed and trialed on a number of different courses at a number of different levels from primary to third level. However, I needed to identify a method for assessing whether any of the existing VLEs would be of use. I needed to consider the functional requirements for my proposed system.

Benchmarking is a common technique used for specifying computer and information systems. Essentially this process involves identifying the functional requirements for the system and then mapping these onto possible proposed installations. I was familiar with this methodology from my teaching and practice in computing. I therefore decided to follow the same process in my requirements specification for a VLE.

Salomon (1995) identified three interconnected elements that he argued were central to the social construction of knowledge. These were:
production/knowledge construction

information sharing

division of labour

These elements were in turn used by Fjuk (1998) to produce a benchmark to assess the potential usefulness of VLEs for use in business training. I decided to apply this framework in a benchmarking process to evaluate VLEs for PISE.

Fjuk (1998) deconstructed the three elements of Salomon’s model for the social construction of knowledge into *interactional* examples:

- searching for information
- planning progress
- making common decisions
- organising groups
- making common plans

Each of the interactional examples has associated with it an *operational* example:

- digital libraries
- mechanisms for personal planning
- synchronous and asynchronous mechanisms
- producing joint information objects
- project management tools

A full list is shown in tables 5.9 to 5.11 in section 5.2.2 below.

My continued attendance at conferences and my reading of the literature helped me to identify one VLE that was widely used. This VLE was Blackboard (Bb).

I therefore examined the full functionality of Bb to see how many of the Bb tools could be used for the operational examples in the Fjuk (1998) framework. I essentially used the framework as a benchmarking tool. I found that the majority of operational examples listed in Fjuk’s framework
were identified in the Bb tools. The final mapping of Salomon’s three interconnected elements, via the Fjuk framework and onto the Bb tools, is fully discussed in section 5.2.1 below. I had found that there was a very good relationship between the tools in Bb and the operational examples of the framework.

The following is a list of the functional tools that were provided (these are described in more detail in Appendix 5_1):

- course announcements
- class calendar
- discussion forums
- chat rooms
- digital drop boxes
- electronic whiteboard
- personal web pages (for students)
- links to learning material
- assignments

And four of these tools had the particular potential to support constructivist pedagogies by supporting learners in the social construction of knowledge. These four tools were:

- discussion forums
- chat rooms
- digital drop boxes
- electronic whiteboard

Although Bb provided an integrated set of tools suitable for a variety of different uses including synchronous and asynchronous communication it had one further, major advantage at this stage in the research process. It offered teachers and lecturers access to its free web server for creation of online courses.
The Blackboard company had established a free Bb web server which allowed teachers to set up online courses which could be accessed from any computer with Internet access. Each course was allowed up to 10Mb of server space. The course designer had access to the full range of Bb functionality, meaning that course developers could ‘get their feet wet’ without any initial costs and only needed access to a web browser to create and manage course sites.

This removed the necessity to jump through the usual organisational hoops before financial and other approval was forthcoming.

Furthermore, the Bb free website listed many hundreds of courses which were organised at different levels and also by subject area. I was therefore able to use this resource to help answer my second research question. Namely were there any PISE type courses already using ICT to support a constructivist pedagogy?

My initial analysis of the several hundred courses on the Bb server identified approximately 100 courses for third level. I carried out a further analysis of these courses and the pedagogies they were adopting.

My first finding was that nobody was using the Bb free web server for a module like PISE or the application of ethical analysis in any other subject area, e.g. business studies, medicine etc.

My analysis also indicated that pedagogies were mainly focussed on storing teaching materials such as Powerpoint slides for lectures, exercises and assignments for lab work and many types of quizzes or multiple choice questions.

I found no evidence of Bb being used to support collaborative learning among the courses I examined. Even those courses that made use of the discussion forums seemed to be primarily using these for exchanging course information between tutors and students. Bb had the characteristics of a VLE that Dillenbourg (2000) had identified, but there was no evidence of it being used on the Bb
free server in the way Stahl et al (2006) had described, i.e. as a support of communications in a learning environment.

So although Bb seemed to offer the features I sought to use with my students, I still had to be sure it would not, at the very least, disadvantage learners in my module. I therefore decided to more formally evaluate Bb and its functionality.

5.1.2 Phase 1.2 Using ICT to enhance group-based learning – a first attempt

5.1.2.1 Overview
Using Bb with students in a ‘real’ situation enabled me to further evaluate this VLE and how it could support teaching and learning in PISE. In this phase of the research I discuss the results of this first attempt.

5.1.2.2 Research method and data gathering
130 students on the PISE course were provided with access to a course site on the Bb free server. The course site had been set up on this server with a number of resources. A group-based assignment that was already part of the assessment for the module was made available as well as a number of related learning materials and links to associated sites. Students were expected to use the collaborative tools of Bb for their group-based discussions on the assignment.

An analysis of the ways in which learners used the Bb system was carried out by recording the types of interactions users had with the VLE.

Feedback was also collected from the students in questionnaires and with interviews. This qualitative data provided an alternative perspective on how Bb was used and gave me ideas for future phases of research.

5.1.2.3 Analysis of data and critical reflection
In this section I discuss the findings from my initial use of Bb with learners in the PISE module.
5.1.2.3.1 Functional use of Blackboard tools
As I discuss in Appendix 5_1, there are four functional areas of Bb. I used these areas to assess the way students used the different tools.

The Content section was the most used function, accounting for about 46% of use. One probable reason for this was the learners’ expectations for a VLE.

At the time I first introduced Bb to my students the main way that computers were used to support learning at UL was in the provision of public folders. These folders were for the use of faculty to enable uploading of lecture notes, assignments and past exam papers. Thus students were more likely to expect to access content when using such systems.

The Communication function was the next most used aspect of Bb. At the class level the main tool used was the Discussion Board. Of the six functions in the Communication Center, the Group pages function was the only one I made available as I was particularly interested in the collaborative nature of usage and how the groups had used Bb. The other functions had been disabled as they were not being used in this phase of the research

I restricted activity in the Group Pages to the Discussion Board. My analysis of the types of use showed that learners used this function for intra-group communication to:

- communicate among group members including:
  - deciding on the case study to adopt
  - allocating tasks
  - debating and discussing the case study
  - production of the report
  - some social chit chat
  - communication between group and lecturer
  - distribution of files
Different groups produced more or less of the different types of intra-group communications, some
making more effort to produce some debate while others did not really successfully manage the
threaded discussions (see 5.1.2.3.2 below).

I was generally pleased with the level of use. It was what I had hoped would happen and illustrated
that the learners were at least using Bb. However, on further analysis some problems became
apparent.

5.1.2.3.2 Early problems with Bb
There were a number of problems manifested during this research phase. These included:

- threaded discussions not developing
- inability among many students to use forums for academic discussion
- volume of text generated much greater than expected
- navigating in Bb
- preference among some students for face-to-face communication

These are now briefly discussed.

I decided that discussions with one or two posts would be considered to have not developed. Often,
when introducing a new topic, learners had a tendency to hit the Reply button even when their post
was not a response to the post to which they were ‘replying’. There were also a significant number
of responses that contained a simple ‘I agree’ or ‘I disagree’ without actually developing the
discussion. And a single post was clearly not a discussion. I therefore decided that a threaded
discussion would be one where there were at least three posts.

My analysis showed that approximately 82% of postings did not develop into threaded discussions.
This is consistent with other recent research on the use of asynchronous communication tools in
higher education (Hewitt and Tevlops, 1999).

It also became clear that some students did not use threaded discussions appropriately. Some
postings that should have been in reply to earlier postings were submitted under new headings.
Other posts, which introduced new topics, were wrongly submitted as part of ongoing threaded discussions. This was something that needed formal teaching input.

As was discussed in Chapter 2, research has highlighted the importance of individual reward in group-based learning and assessment. I therefore decided to allocate some marks for individual contribution to the group work. Students either had to indicate clearly on any submitted work who had undertaken particular tasks, or they could submit discussion board content for assessment. This approach was developed further in future cycles of the research.

The volume of text generated was much greater than I anticipated. Learners produced many more posts than was expected. In some instances over twice as many words were produced than was expected for the assignment (i.e. in excess of 12,000 words for a 6,000 word assignment). There were obvious overheads in terms of just reading all of these for both students and lecturers.

A further problem was due to navigation in Bb. To get to any threaded discussion required the traversal of five levels. This meant that it took considerable time just to access discussions.

The final problem concerned use of the VLE for asynchronous online discussions. Some students expressed a preference for face-to-face communication. They did not see the point of using Bb when they often met with their colleagues in face-to-face situations.

However face-to-face communication can be unfocused compared to the use of written communication, which is asynchronous by its very nature. As was mentioned earlier, research had indicated the usefulness of asynchronous collaborative communication, because of its reflective nature. It was therefore necessary to find a way to encourage use of this function in Bb.

As a response to this student concern I decided I would allow groups to submit their discussion board postings as part of their final report. Thus the time and effort spent producing posts in a threaded discussion would be. I also hoped that this would also give an added incentive to engage in the online discussions. This proved to be so and is discussed in following research phases.
5.1.2.3.3 Advantages

Although there were problems using Bb there were also some significant advantages including:

management –
self-organisation students into groups
selection of topics, tutorial times and presentation slots
communication
lecturer to student
student to lecturer
student to student
intra-group collaboration using self-regulated discussion groups

Management of the module including the formation of groups, topic selection and identification of slots for tutorials and presentations was significantly eased. I needed to spend much less time on this aspect of course management because students managed this process themselves using the Bb Main Discussion Board.

There were also advantages in relation to student questions about the course content. The answers to a student inquiry were available on the main discussion board for all to see, thus saving me time by not having to repeat explanations to different students who previously would have called individually to my office for assistance.

Using Bb allowed students and lecturer to be more involved with the module and with each other and went some ways to dealing with the problems associated with such large cohorts, one of the initial drivers of this research.

Communication between lecturer and student had also been greatly enhanced with the use of the discussion boards. These factors meant that I had considerably more time to deal with ‘real’ problems about understanding the course material instead of spending so much time dealing with management problems.
Finally I was able to point to the ‘audit trail’ that was produced by individual students in their group discussions as evidence of individual contributions to the group assignment. Although I did not, at this stage, use this in the grading process it was a function of this VLE that had obvious potential when dealing with examiners’ concerns. This is discussed below.

5.1.2.3.4 Student feedback
At the end of the semester the module was evaluated using an anonymous questionnaire and student views on the use of Bb were sought.

Positive comments included the following:

‘Bb helped with communication within the group’

‘…kept a good list of all the discussion we had for future reference’

‘It gives you the chance to express your opinion without fear of humiliation because it is only viewed by 6 people’

‘Bb is a very valuable tool for cooperating on projects’

‘It was useful for the scenario, as ideas can be developed on it’

Negative comments were focused on the necessity for such a tool in groups that saw each other on a regular basis, and technical problems using Bb.

‘Our group… found face-to-face meetings were far better for getting our points across’

‘It would be more useful… to students who don’t have face to face contact’

‘ connections timed out and made it difficult to maintain a flow in what you were writing’

‘I lost some messages just as I was about to send them and this was very frustrating’

‘It can be a bit tedious to find out if somebody has responded to your post as you have to go through so many other page to get to the discussions’

‘Some users did not respond properly to messages and did not answer specific questions about what they had posted’

‘I found it difficult at times to enter the right response in the right thread.’

In general, students found it challenging to have use this approach and some also indicated that it made them think more deeply about their own contributions before posting a message to the
discussion board.

‘Everybody can see what you’ve written, it’s not like chatting, there is a record, so you’re inclined to stop and think before posting something’

It therefore appeared that my initial research question would provide a positive result. But there was much more work to do before I could be sure.

5.1.3 Phase 1.3 Finding a partner for multi-institutional collaboration

5.1.3.1 Overview

One of the main issues identified by students was the appropriateness of using Bb for asynchronous discussions when learners regularly met with each other in face-to-face situations. In essence it was a contrived learning situation. However, I was aware of the increase in the use of geographically distributed groups in multi-national organisations. Some colleagues at UL were involved in research in this area. I therefore decided to investigate if this could also work in teaching and learning in PISE. I began to develop a set of requirements for potential partners.

It was imperative that I did not embark on a collaboration that might have negative consequences for my students. I therefore needed to research in detail the type of situations that could impair my students potential. This was the driver for this phase of the research.

After consideration I identified the following requirements for collaborators:

- the need to have broadly similar course content
- use (or at least agreement to use) similar pedagogic methods, i.e. group-based pedagogy with problem-based learning and assessment
- students of approximately the same level of study, in this case undergraduate,
- courses needed to be running in the same semester as at UL
- courses should be of similar length and have similar weighting or credits in respect of the total degree
- a good grasp of English as this would be required to discuss ethical issues
5.1.3.2 Research methods and data gathering

The research methods I adopted consisted of the following:

- search for course similar to PISE using online tools
- analysis of course content found from above research protocol
- search of journals for articles on PISE related topics and examination of author affiliations to identify potential partners
- identification of online discussion lists used for PISE related teaching and research
- notification of my requirements to appropriate lists identified from above
- analysis of responses to my enquiries

These are now briefly discussed.

My first task was to find if there were any other courses or modules that covered the same area as PISE. Unfortunately these are called many different names: Computer Ethics and Society, Professional Studies, Computers, Society and Information Studies, Issues in Computing and IT and many other variants of these. It was also necessary to search wider than just in Computing and IT departments as sometimes these modules were offered by Philosophy departments.

Each time I found a module that looked similar I had to further research the content. Many universities had little module information available on their websites. My searching was not helped by the fact that many websites were out of date or even sometimes referred to modules that were no longer on offer.

A further method I adopted was to search through journals and identify authors who had published research in computer ethics in the hope that they might also be teaching in this area.

A further research strategy was to ‘advertise’ on certain newsgroups to find a collaborator.

There are many mailing lists or newsgroups where teachers and researchers in the area of Professional Issues in the computing domain communicate and discuss questions of common concern. JISCmail and Mailbase in the UK were two of the most widely used lists for those
teaching and researching in third level education. Both had sub-lists for those teaching and researching Computer Ethics and Professional Studies. Another list was the LTSN-ICS set up as part of the UK-wide project into the use of computers in teaching. This list had sub-areas for different subjects including one for PI and ethics. (In fact my first conference paper on this research was the LTSN conference in 2001 in London).

In the US Listserve and Usenet lists, which while not being specifically academic resources, were used by many researchers as a means of building online communities and had academic discussion areas.

I posted general requests on all of these lists for a partner institution to collaborate (see typical email below).
The result of this research eventually produced a small list of potential collaborators.

5.1.3.3 Analysis of data and critical reflection

Having ‘advertised’ my search for collaborative partners I received 14 replies which needed assessing for appropriateness.

This 'first cut' eliminated nine potential collaborators because of their unsuitability. The main reason was organisational as other institutions did not offer this module in the same semester as UL.

Of the remaining five three had to withdraw because they were unwilling or unable to make the required changes to their modules. These changes were mainly to do with the altered approach to
assessment or the weighting being given for this particular assignment. Some of those who had expressed interest would not have been able to gain the required institutional permission before I was to teach the PISE module at UL. That left just two institutions.

I continued discussions with these two and after some email communications it became apparent that Sacred Heart University (SHU) and de Montfort University (DMU) were both suitable partners for this phase of the research study. The reasons for this are now discussed.

Prof. Grodzinsky from Sacred Heart University (SHU) taught an undergraduate class. The Computer Ethics: Society and Technology (CEST) unit she taught had much in common with PISE in content. Appendix 5_2 contains her course description.

In summary I discovered the following positive aspects about the SHU course:

- it was the same length as mine
- students at SHU were undergraduates studying computer science – the same as mine
- course content largely overlapped with PISE
- a constructivist philosophy underpinned the pedagogy used at SHU
- Prof Grodzinsky already had experience using Bb with her students
- there was similarity in the way the CEST and PISE modules allocated part of their marks for posting to online threaded discussions

The upshot was that there would not need to be any dramatic change to the way either of us taught and assessed this component of the modules.

The second potential partner was de Montfort University (DMU). This university is well known for its central role in the research and teaching of computer ethics. It is the home of the Centre for Computing and Social Responsibility (CCSR) whose mission is ‘Addressing the social and ethical impacts of information and communication technologies through research, consultancy and education’.
Pat Jefries was responsible for teaching the PCICT course at DMU. She also had a personal interest in the use of online tools to support learning and was carrying out research into this.

In summary I discovered the following positive aspects about the DMU course:

- it was in similar length as mine
- students at DMU were undergraduates studying computer science – the same as mine
- course content overlapped largely with PISE
- there was a culture of support for teaching Professional Issues at DMU

Pat Jeffries had strong teaching and research interests in the use of ICT in teaching the PICT module at DMU

Appendix 5_2 contains the course description for PICT at DMU.

So by mid January, about two weeks before the PISE module started in the UL Spring semester, I had identified two collaborators for the next phase of the research.

However, I quickly discovered a major problem. DMU would need more time to get the necessary permissions to collaborate and make changes to their module description. They would not be able to participate in the next teaching cycle.

I was left with only one option, to continue the collaboration with just SHU and to re-visit this research theme the following year and see if DMU could then join the partnership.

My aim in this phase of the research had been to establish a multi-institutional collaboration in response to concerns raised by my students in the previous phase of this study. It was important that in adopting this pedagogical strategy my students were not disadvantaged. This led to a rigorous search for suitable a partner and the eventual identification of two institutions, SHU and DMU.

Having ascertained that there was a good match between us it then became a matter of setting up the multi-institutional collaboration which is the focus of the next phase in this cycle. Unfortunately I had to proceed with just one partner, SHU. This is discussed in the next section.
5.1.4 Phase 1.4 Further use of VLE in PISE: A first multi-institutional collaboration

5.1.4.1 Overview
In this phase I describe how I introduced a multi-institutional collaborative approach into the teaching and learning methods being researched.

The collaboration took place over a ten-week period. Two weeks in the middle of this period were the SHU Easter holiday and another weekend was the St Patrick’s Day holiday weekend in Ireland. However we decided that students could still use Bb to post during their holiday periods. This did however cause some problems which are discussed below.

5.1.4.2 Research methods and data gathering
Following the identification of a collaborative partner I repeated the research process used in previous phase, namely:

- creation of learning groups, but this time consisting of learners from two institutions
- using Bb to facilitate the teaching and assessment of the PISE module
- gathering and analysis of data on how Bb was used – quantitative
- collection and analysis of student feedback – qualitative

There were also some specific tasks for both collaborating institutions including:

- development of an agreed set of case studies
- creation of an agreed marking scheme

Data was collected using the Bb Course Statistics tool as described in Appendix 5_1. This enabled me to gather quantitative data on student usage patterns of the different functional components of Bb. I also asked students to answer an anonymous online questionnaire and conducted interviews with some students to gather qualitative data. This qualitative data was recorded in my personal journal, and used with the quantitative data to help define further cycles of research.

More details describing the setting up of groups, some ethical considerations and an initial socialising phase are described in Appendix 5_3.
5.1.4.3 Analysis of data and critical reflection

In this section I discuss my analysis of the data collected in this phase. I have divided this into a number of sub-sections for ease of reading.

5.1.4.3.1 Usage patterns

The first level of analysis was on the level of Bb functional area use. Table 5.1 below provides a breakdown on this. The Content functional area gives the level of use for accessing learning resources. The Communication and Groups functional areas show levels of use for cohort-wide and group communications. Student tools included facilities such as creating personal web pages and updating personal profiles.

<table>
<thead>
<tr>
<th>Function area</th>
<th>Hits</th>
</tr>
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<tbody>
<tr>
<td>Content</td>
<td>15904</td>
</tr>
<tr>
<td>Communication</td>
<td>10229</td>
</tr>
<tr>
<td>Groups</td>
<td>7340</td>
</tr>
<tr>
<td>Student tools</td>
<td>239</td>
</tr>
<tr>
<td>Total</td>
<td>33712</td>
</tr>
</tbody>
</table>

Table 5.1 Activity level for multi-institutional online collaboration.

I identified two reasons for the high number of page hits for the Content function. Both Prof Grodzinsky and myself made a large number of resources available to students on the course site and these had obviously been heavily accessed.

A further reason for the high level of Content ‘hits’ was the way Bb recorded statistics. Each time a user logged on, or displayed the Main page, which was also the Content page, a hit was recorded for this function.

Communication functions are listed in Table 5.2 below. As can be seen a number of these were disabled as they were not useful as collaboration tools. As with the previous phase the Main Discussion Board was mostly used to manage the module practicalities. Use of this part of the system again decreased as these management issues were dealt with and the module progressed.
The Main Discussion Board recorded 2889 hits. However, by far the greatest number of hits was for
the Group pages function which was the primary functional area for group-based collaboration.

<table>
<thead>
<tr>
<th>Communication Function</th>
<th>Hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Send email (class level)</td>
<td>0 (disabled)</td>
</tr>
<tr>
<td>Main Discussion board</td>
<td>2889</td>
</tr>
<tr>
<td>Student roster</td>
<td>0 (disabled)</td>
</tr>
<tr>
<td>Virtual Chat</td>
<td>0 (disabled)</td>
</tr>
<tr>
<td>Student pages</td>
<td>0 (disabled)</td>
</tr>
<tr>
<td>Group pages</td>
<td>7340</td>
</tr>
</tbody>
</table>

Table 5.2 Functional use of Communication Function.

Table 5.3 below shows my further analysis of the use of the different tools in the Group pages.

<table>
<thead>
<tr>
<th>Tool</th>
<th>Hits</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group discussion board</td>
<td>6844</td>
<td>93.2</td>
</tr>
<tr>
<td>Send Group Email</td>
<td>121</td>
<td>1.64</td>
</tr>
<tr>
<td>File Exchange</td>
<td>107</td>
<td>1.45</td>
</tr>
<tr>
<td>Group Virtual Chat</td>
<td>268</td>
<td>3.65</td>
</tr>
</tbody>
</table>

Table 5.3 Details of usage of Group Pages tools.

As can be seen the discussion board tool was the most used. This was to be expected as the focus of
Bb use was collaborative online discussion in geographically dispersed groups. Bb was the main
point of contact between group members (although there was some anecdotal evidence that some
learners used private email and other online chat services) and this tool provided the functionality to
enable such communication to take place.

I then undertook an analysis of the discussion board posts to identify the level of discussion
threads development. Table 5.4 shows the number of threads of varying length.

<table>
<thead>
<tr>
<th>Length of thread</th>
<th>No. of threads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single post</td>
<td>297</td>
</tr>
<tr>
<td>Two posts</td>
<td>445</td>
</tr>
<tr>
<td>Three posts</td>
<td>126</td>
</tr>
<tr>
<td>Four posts</td>
<td>180</td>
</tr>
<tr>
<td>Five + posts</td>
<td>191</td>
</tr>
</tbody>
</table>

Table 5.4 Thread lengths.

The total number of unique posts was 3476 (this is different to the page hits recorded because the
Course statistics function of Bb was also recording views as well as posts).
Once again I applied the same criteria as described above (5.1.2.3.2) to define discussions. My analysis showed that this time the total number of discussion that developed was 41%. This was a marked improvement of the percentage of threaded discussions compared to the previous, single-institution, study which was just 19%. This suggested to me that the multi-institutional approach could be responsible for encouraging this type of discourse. However, I believe this was also in part because of the increased guidance I gave my students and the requirements of effectively debating with geographically dispersed team members.

We adopted an agreed marking scheme (Appendix 5.0). Using this marking scheme both myself and Prof Grodzinsky independently graded each report. We then compared our individual grades and found that we had agreed on six of the nine group grades. The remaining three grades were also agreed after some little discussion.

In comparing marks achieved in this study with the previous one using Bb, I found that there was an average increase of 8% in marks awarded. Now while this may have been for a wide number of reasons it did seem to indicate that I was pursuing a potentially successful pedagogical approach. At the very least, it did indicate that my students were not being disadvantaged by this approach.

5.1.4.3.2 Student feedback

Students were asked to complete a module evaluation online questionnaire anonymously.

Approximately 50% provided feedback using the questionnaire. Below is a sample of the responses which highlight some of the problems and the advantages identified by students.

A major driver for this multi-institutional collaboration was student dissatisfaction with having to use online collaboration when they frequently met face-to-face. Feedback from students in both institutions showed that they did not have the same negative attitude when working as members of geographically dispersed learning teams.

However, among the management issues was the problem that holidays did not coincide. We had assumed that students would be able to work around this but in fact the vast majority of SHU
students took the full two week Easter holiday and UL students had time off for St. Patrick’s Day. This forced us to extend the assignment period to accommodate this break and was distracting for the UL students particularly.

The following comments illustrate some of these points.

‘I'm definitely enjoying what we are doing here, the fact that I'm the only American left in the group makes it hard to discuss with a classmate but I've brought the project as far as talking to my friends sitting around on the beach about this stuff?’

‘Well isn't it well for some? Sitting on the beach!! …I think this international collab is a great experience. It does, as you say, make you think more about consequences and it's good getting different perspectives so do continue to play devil's advocate!' 

‘In all seriousness that was a problem, some of the SH students were just not around when we were in the middle of this and we also had demo day a day [for the UL students final year project demonstration] to prepare for. Made it really difficult’

‘Yeh but you guys weren't always around either. Some of you had a few days off for St Patrick’

A further problem developed because learners were in different time zones.

Some learners instinctively seemed to prefer synchronous communication. I reiterated that the basis of this pedagogical strategy was the belief that allowing time for reflection would enhance learning which was facilitated by asynchronous communication. But some students continued to use synchronous communication channels in order to be online at the same time. Some students used IRC outside of Bb and some UL students stayed up late into the night to be online simultaneously with the SHU students.

‘I found it difficult to collaborate because of the time difference.’

‘misinterpretation and inconsistency is more likely when using the blackboard. It's not as reliable as real time conversations’

‘Difficult to receive instant feedback’

‘very hard to get things done as you'll never get people together at the same time for discussions and as a result things take a lot longer’

‘Hard to communicate effectively. Ideas were not being fully incorporated by all involved as its difficult to make decision without direct communication.’
A further issue related to the weighting given to this assignment. At UL it accounted for a higher weighting than at SHU. We had not considered that this might be a problem, but the following suggests differently.

‘I think the difference of marks for the Irish and US students was a big problem. US were getting 20% and we were getting 45% this is obviously going to reflect the effort a person is willing to give the project.’

Related to this were the additional pressures from other parts of the degree programme.

‘Also as the course is run in the final semester here at UL having two major projects in one module is totally unrealistic, but this is more of a module issue’

Many of the students found it an interesting and fulfilling experience to work online with other learners they might otherwise never have collaborated with.

‘Ability to gain new insights from people around the world’

‘… strengthens communication skills’

‘Working with other people that have differences is a very essential skill that should be learned early’

‘We got the opportunity to learn about the various ethical theories and their application through direct interaction with students from another country. This interaction was invaluable as it allowed us to gain experience in the use of an online collaboration tool while at the same time proactively pursuing a goal’

‘Develops a realisation of the difficulty of working with people of whom you have no knowledge and do not meet and the difficulty of working over the net.’

‘Being a part time student I have been exposed to many different methods of working on projects - this approach is not unusual. This project has given all students involved the opportunity to share ideas with others outside their normal group and also from different cultures.’

Learners were also asked to consider their attitudes to use of the Bb system.

‘being restricted to using blackboard made us use it properly, learn to work with more respect and allowed full organisation for work. learned how to communicate effectively with typed words rather than spoken’

‘I liked the BB system. All work is located at same place. All ideas are conveyed in the same format’
As well as these responses students were asked to respond to a number of closed questions each with three possible answers. The results follow.

Choose the response that comes closest to the way you feel about the international group project. Collaborating with students from abroad was...

<table>
<thead>
<tr>
<th>Response</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>not worthwhile</td>
<td>4%</td>
</tr>
<tr>
<td>somewhat worthwhile</td>
<td>65%</td>
</tr>
<tr>
<td>very worthwhile</td>
<td>31%</td>
</tr>
</tbody>
</table>

As a medium for collaborative work, Blackboard was...

<table>
<thead>
<tr>
<th>Response</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>not worthwhile</td>
<td>9%</td>
</tr>
<tr>
<td>somewhat worthwhile</td>
<td>57%</td>
</tr>
<tr>
<td>very worthwhile</td>
<td>36%</td>
</tr>
</tbody>
</table>

As compared to other assignments in the course, the international group project was...

<table>
<thead>
<tr>
<th>Response</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>less worthwhile</td>
<td>13%</td>
</tr>
<tr>
<td>equally worthwhile</td>
<td>48%</td>
</tr>
<tr>
<td>more worthwhile</td>
<td>39%</td>
</tr>
</tbody>
</table>

In terms of increasing one’s understanding of ethical theories/analysis, the international group project was...

<table>
<thead>
<tr>
<th>Response</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ineffective</td>
<td>16%</td>
</tr>
<tr>
<td>somewhat effective</td>
<td>52%</td>
</tr>
<tr>
<td>very effective</td>
<td>32%</td>
</tr>
</tbody>
</table>

As can be seen, on all of these questions the majority of responses were positive. Students had overall positive attitudes to the concept of international group collaboration and felt that it increased their understanding of the course content. They also had a positive attitude to the Bb VLE. An set of responses that greatly encouraged me in this research.

5.1.4.3.3  Faculty feedback

There were some problems with this collaboration. Following analysis of feedback and discussions with Prof Grodzinsky I identified the main points that needed addressing:

- need to help groups establish more successfully
- management issues such as timing
- need for guidelines for using bulletin boards and developing threaded discussions
- development of methods for assessing the success or otherwise of this pedagogy
Although there was an improvement in the development of threaded discussions, there were still problems related to the development of threads. There was still a good number of single posts, replies that simply agreed or disagreed with the initial posts or posts that changed subject although posted as replies. In effect students seemed to be experiencing some problems using this medium of communication for in-depth discussion and debate. More work needed to be done to teach students how to conduct proper discussion and debate.

Some posts were overly long and contained links to other resources. This made them difficult to follow and it was also obvious that some of the information was not being read by learners. Sometimes links were also incorporated without any critical reflection or observation by the poster.

I used my analysis of posts and possible problems encountered by students to develop a guidance document for future cycles. This is shown below.

![Figure 5.3 Guidelines for posting in a discussion on Bb.](image)

An interesting outcome was the way the learners ‘taught’ each other certain concepts which may have contributed to a deeper understanding of the course content. Although both courses ostensibly covered the same material, students did have different areas of knowledge and used this to expand each others’ understanding.

There was an apparent increase in the average grades between this teaching phase and the earlier, single institution phase. It warranted further analysis, but the data suggested to me that there was an improvement in student learning using this approach.
Another outcome came to light following an appeal by one of my students against the grade awarded for this assignment. I was able to demonstrate to the student concerned the transparency of the grading process by reference to the audit trail of individual contributions in support of my assessment of the mark awarded. As a result, the appeal was withdrawn by the student concerned. I had coincidently found a way of defending my individual marks. I discuss this later.

A major advantage of this multi-institutional approach was having more than one faculty available to deal with student queries. This lightened the workload for me. However we had to develop a timetable so that we did not both spend the same time reading and responding to student questions. We organised a rota so that each group would have their posts read and questions answered by one of us on at least two occasions per week. We also responded to direct requests for help at other times if required.

Internet access speeds once again caused problems. Using the free Bb server meant that we sometimes faced considerable delays in accessing parts of the course site. This was frustrating for some students, especially when some of their posts did not get published in a timely manner which broke the flow of discussion. This happened because a team member could clearly not respond until a post had appeared in the forum.

The use of the Bb VLE continued to be somewhat problematic due to its design. This were principally with the navigation. As mentioned previously, this required up to five levels of access just to undertake some tasks such as reading and/or responding to a post on the group discussion board.

This use of the free server enabled me to use the VLE in a real situation. However, the Bb company only provided access to servers with limited capability. As a result this often lead to significant delays in response times. This, combined with the previous issue, added to user frustration at times.
Overall I felt that the multi-institutional approach was a pedagogy worth exploring further. There were some ongoing problems and others that I had not foreseen. However, on a number of crude measures enhancement of student learning appeared to be occurring by using ICT to support the multi-institutional collaboration.

5.1.4.4 After note to Phase 2
Following the success of this phase I decided to recommend to my Head of Department that we invest in necessary hardware so we could run our own Bb server. Following discussions it was agreed that a three-year licence for Blackboard and the necessary hardware be purchased.

I was now ready, with my own Bb server, to consider further ways of developing this pedagogical strategy.

5.1.5 Phase 1.5 Second multi-institutional collaboration – collaborating with three institutions

5.1.5.1 Overview
The next teaching cycle enabled me to continue with my research and this time all three institutions were collaborators. In the following sections I discuss this phase of the research.

5.1.5.2 Research methods and data gathering
This research phase followed the same pattern as the previous two phases already discussed above. The main difference being that his time students from three universities, UL, SHU and DMU, comprised the ‘international’ groups.

Overall there were fewer students in this study than in the previous phase. This was due to the size of the cohorts in SHU and DMU. In SHU here were only twelve students as opposed to 25 in the previous study. It was decided that as far as possible the groups would be comprised of 2 students from each institution and this had the effect of determining the total number of participants in the international study. Table 5.5 below shows the make up of the groups.
We had already decided that the learning and assessment process would proceed as in the previous studies, i.e. a scenario-based project, in which each group would choose a scenario, conduct an analysis and present a collaborative paper based on their research and threaded discussions.

Creating a timetable was again one of the more difficult administrative tasks because each course started at a different time and vacations in the three countries did not coincide. Despite this constraint we identified an eight-week period of overlap. It meant some adjustment to the order in which topics were covered but this was a surmountable problem.

Each lecturer agreed to ‘visit’ the group pages weekly to offer support to the groups and direction where needed. In the Course Documents section of Bb, lecturers posted the project guidelines, scenarios and learning material from their own courses.

Once again statistics were gathered using the Course Statistics tool and feedback from students was gathered using anonymous online questionnaires and interviews. Faculty also provided feedback via online discussion.

### 5.1.5.3 Analysis of data and critical reflection
As with the previous phase I collected both quantitative and qualitative data. I also collected feedback from students and from Prof Grodzinsky and Pat Jeffries. This is now discussed.

#### 5.1.5.3.1 Usage patterns
There were approximately 23,752 hits in total over the entire period. These were categorised using the functional areas of Bb and are shown in the following table.

<table>
<thead>
<tr>
<th>Group</th>
<th>Limerick</th>
<th>De Montfort</th>
<th>Sacred Heart</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Int 1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Int 2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Int 3</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Int 4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Int 5</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Int 6</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Int 7</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
<td>9</td>
<td>12</td>
<td>37</td>
</tr>
</tbody>
</table>

Table 5.5 International group make up.
<table>
<thead>
<tr>
<th>Function area</th>
<th>Hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td>10959</td>
</tr>
<tr>
<td>Communication</td>
<td>5643</td>
</tr>
<tr>
<td>Groups</td>
<td>6971</td>
</tr>
<tr>
<td>Student tools</td>
<td>179</td>
</tr>
<tr>
<td>Total</td>
<td>23752</td>
</tr>
</tbody>
</table>

Table 5.6 Breakdown of functional activity on Bb.

Overall there were fewer hits but this was to be expected due to the smaller number of participants. Once again the Content was the most used function but this can in part be explained by the way Bb collected statistics and the provision of some course material by the different lecturers.

The Group Pages was where the collaboration took place, so I analysed the use of the group area tools.

<table>
<thead>
<tr>
<th>Tool</th>
<th>Hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Discussion Board</td>
<td>6134</td>
</tr>
<tr>
<td>Email</td>
<td>159</td>
</tr>
<tr>
<td>File Exchange</td>
<td>502</td>
</tr>
<tr>
<td>Group virtual chat</td>
<td>176</td>
</tr>
</tbody>
</table>

Table 5.7 Functional use of Blackboard within the Groups Pages.

Table 5.7 shows that although all tools in the Group Pages area were used, the group discussion boards were once again by far the most popular.

As part of the assignment it was decided to give students the option to submit for assessment that part of their group discussion board that related to the moral dilemma scenario instead of the usual written report. For the threaded discussions, postings could be ascribed to individuals thus enabling the measurement of individual contributions. Three out of the seven groups submitted their threaded discussions as part of the final report.

The group discussion boards were analysed to see what percentage of threaded discussion had developed. I used the same criteria as in the previous study. Any thread with three or more posts was considered to be a threaded discussion.
<table>
<thead>
<tr>
<th>Length of thread</th>
<th>No. of threads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single post</td>
<td>184</td>
</tr>
<tr>
<td>Two posts</td>
<td>324</td>
</tr>
<tr>
<td>Three + posts</td>
<td>424</td>
</tr>
</tbody>
</table>

Table 5.8 Analysis of thread lengths.

As can be seen from Table 5.8 above the percentage of posts that developed in threaded discussions was 45.5%. Although this was a slight increase on the previous phase it did not constitute a large improvement. I felt it indicated that more work needed to be done on teaching learners how to build a threaded discussion.

Marking was carried out by each lecturer independently using the existing scoring rubric. We agreed initially in the majority of cases but some discussion had to take place with three groups. Eventually we arrived at an agreed set of marks for all the groups.

Once again using the measure of grades showed a slight increase of 2%. This was again a trend in the right direction but it was a very crude measurement of learning. I therefore identified that an alternative method of assessing student learning was necessary. This is discussed in Cycle 3 following.

5.1.5.3.2 Student feedback

Students were asked to respond anonymously to an online survey. Some students also provided feedback via their discussion boards on Bb. Others agreed to be interviewed. This feedback helped to identify positive and negative aspects of the pedagogy.

Management issues continued to be somewhat problematic. The different calendars and the weighting given by the different courses to this assignment were the subject of some comments.

‘... however felt deadlines and international collaboration weren’t organised too well. i.e. international students report was worth less to them then to the Irish students therefore they didn’t work as hard, the students not doing the international collaboration had more time to do their report, when it was easier to do it this way.’

‘I think the first submission was rushed ... but maybe this is to fall in with the other universities semesters?’

‘The main negative thing is the dedication of the people involved’
There were still some concerns about the time difference but far fewer than in the previous phase.

‘The time difference was very difficult to work with and presented some difficult obstacles’

‘Due to time differences it was often difficult for the group to actually really discuss any topic in detail.’

‘it could take days for some of the team members to contribute’

‘Group work is always difficult but I don't believe the fact that it was international made a difference other than not being able to meet and the time difference.’

A new problem this time was the different levels of commitment by students in the different universities. This was seen as being a barrier to the development of discussion and the eventual quality of the finished report.

‘It was extremely difficult to motivate team members due to the distance between us. The [Country A] members of our team did not participate at all and this made it hard to complete the report to the required level. It also meant a considerable amount of additional work for the rest of the team.’

‘The idea works as a whole but its ease is very dependent on effort from international colleagues.’

‘Was difficult to get all team members on the same wave length as everyone else.’

‘[College A] students didn't reply to any of our mails or requests.’

‘there was a general opinion that the [Country A] groups were not as interested as the [Country B/Country C] groups.’

‘all group members did not participate’

‘...because all the students were working to different deadlines with regards the rest of their course work, it sometimes caused conflict’

‘It was hard to develop proper lines of communication with international students. If a student decided not to participate in the activities there was no direct means of contact. It was difficult to establish a meeting due to peoples varying schedules and the time difference’

‘It was hard to get everyone in the group to work and do there (sic) parts’

‘I have no problem working with others and putting their ideas above my own but I would at least like reasoned responses which is hard to do among a group of people who do not know each other’

But other groups seem to find this no problem:
‘it was great interacting with different cultures and learning so much from them, and when organised our work came together very well, even though we were seas apart’

‘Group members are committed and enthusiastic’

‘Quite enjoying the International group, no major communication problems’

‘Blackboard system was very helpful and working with foreign students provided a good experience’

But the structure of Bb continued to be a barrier to some.

‘- need for message alert’

‘...problem of knowing when somebody had responded’

As well as these responses students were asked once again to respond to the following closed questions each with three possible answers:

Choose the response that comes closest to the way you feel about the international group project.

<table>
<thead>
<tr>
<th>Collaborating with students from abroad was...</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>not worthwhile</td>
<td>8%</td>
</tr>
<tr>
<td>somewhat worthwhile</td>
<td>58%</td>
</tr>
<tr>
<td>very worthwhile</td>
<td>24%</td>
</tr>
</tbody>
</table>

As a medium for collaborative work, Blackboard was...

<table>
<thead>
<tr>
<th>Blackboard was...</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>not worthwhile</td>
<td>14%</td>
</tr>
<tr>
<td>somewhat worthwhile</td>
<td>56%</td>
</tr>
<tr>
<td>very worthwhile</td>
<td>30%</td>
</tr>
</tbody>
</table>

As compared to other assignments in the course, the international group project was...

<table>
<thead>
<tr>
<th>International group project was...</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>less worthwhile</td>
<td>21%</td>
</tr>
<tr>
<td>equally worthwhile</td>
<td>43%</td>
</tr>
<tr>
<td>more worthwhile</td>
<td>36%</td>
</tr>
</tbody>
</table>

In terms of increasing one’s understanding of ethical theories/analysis, the international group project was...

<table>
<thead>
<tr>
<th>Ethical theories/analysis was...</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ineffective</td>
<td>7%</td>
</tr>
<tr>
<td>somewhat effective</td>
<td>53%</td>
</tr>
<tr>
<td>very effective</td>
<td>30%</td>
</tr>
</tbody>
</table>

I was pleased to see that the answers to the closed questions continued to have a positive bias despite some of the negative comments recorded on the online questionnaire.

5.1.5.3.3 Faculty reflections
Our own discussions following the collaboration enabled us to identify some particular issues and
outcomes. The most notable of these were:

the need to ensure more similar weighting for this assignment so that all students contributed more equally

the asynchronous nature of the tool (often students were waiting before they could move on to the next task) caused delays with some groups in completing tasks

lack of organization skills of students in using this kind of media for division of work (they just expected things to happen rather than specifically articulating them) should be addressed with some specific input from lecturers or teaching assistants

lack of roles within the group (the groups that achieved the highest grades, took our suggestion to have group roles, those that did not had no leader or organizer and students just expected others to do the work) meant that some groups did not allocate tasks and duties

the online nature of the pedagogy may have seemed less pressing because it was virtual and not ‘real’ (no tutors constantly monitoring progress as opposed to other course where there might be constant pressure from regular face-to-face-meetings)

indeterminate length of online collaboration period contributed to above

allowing virtual groups to self-organise (setting own deadlines and milestones) may have contributed to ‘slippage’ in completing tasks

more formal exercises to encourage the ‘social’ aspects of group formation and to enable members to get know each other, to articulate their strengths and weaknesses

5.1.5.3.4 Outcomes
The outcomes were in many cases developments of the trends identified in the previous phase of this cycle when I first set up a multi-institutional collaboration. In general I found the following overall advantages were still being achieved:

class management was easier, i.e. posting of course material, self-organising of groups, selection of topics and case studies etc.

communication between lecturer and students was more straightforward using Course announcements, Group email and Discussion board functions

inter-group communication was facilitated using Group discussion board tool

observation and participation by lecturers enhanced learner support
The percentage of threaded discussion increased by about 10% so some of the advice I had produced following Phase 2 appeared to have made a difference. I therefore decided to produce a more comprehensive set of guidelines on this topic in an effort to provide some formal teaching input on this communication skill.

Once again I found that students enjoyed the experience of ‘meeting’ others from other universities and sharing knowledge with each other. But there were still some problems including:

1. differing levels of commitment from the collaborating students due to the difference in weighting given to this assignment
2. use of synchronous communication as a way of coping with different time zones did not fit in with the asynchronous pedagogy being used and evaluated
3. different vacation and semester dates continued to cause headaches with some group members being absent at critical times and thus slowing or stopping discussion.
4. the cumbersome way that Bb adopted when accessing functionality continued to cause problems with some operations such as accessing discussions

5.2 Justification from the literature

In this section I discuss my analysis of the literature related to the phases in this cycle of action research.

5.2.1 VLEs
The relationship between pedagogies, attainment of higher-order critical thinking and ICT has been discussed extensively in Chapter 2. In this section I focus on virtual learning environments (VLE).

Since the middle of the 1980s research had been growing in the area of computer supported cooperative work (CSCW). CSCW focuses on the use of technology to support groups or teams of workers. One of the early focuses (Grief, 1986) was in the development and use of software tools such as conferencing software to enable geographically distributed teams to effectively communicate while working on common projects.
Following research into available ICT I became aware of a family of tools known as Learning Management Systems (LMS) or Content Management Systems (CMS). (Subsequent refining of definitions have now differentiated these tools from Virtual Learning Systems (VLE) which more correctly refer to the tools used in this study. However there are still differences in the terms used in different countries. Among other names uses are: Course Management Systems (CMS), Learning Content Management Systems (LCMS), Managed Learning Environments (MLE), Learning Support Systems (LSS), Online Learning Centres (OLC) or Learning Platforms (LP). I will use the term Virtual Learning Environment from here on.) This family of tools had grown out of research into the computer-supported collaborated learning (CSCL).

Dillenbourg (2000) identified some characteristics of VLEs. These are:

- the information space has been designed, it is not just an ad hoc collection of web pages
- a VLE is a social space where there is social interaction about or around information. It may have synchronous and asynchronous communication allowing one-to-one, one-to-many, many-to-many modes using text, video or audio media
- educational interactions occur in the environment
- the information/social space is explicitly represented. The representation varies from text to 3D immersive worlds but certainly includes navigation tools
- students are not only active, but also actors. They co-construct the virtual space using a ‘set of activities in which the students construct and share objects’
- VLEs are not restricted to distance education but can be used in any learning situation
- VLEs integrate multiple tools just as a physical learning environment has an integrated range of facilities for learners (e.g. library, seminar room, lab etc.).
- the virtual environments will probably overlap with physical environments enhancing the overall learning experience (what is now referred to as blended learning)

Dillenbourg (2000) also proposes the following functions that are shared by VLEs:
manage users, roles (student, teacher, assistant etc.), courses, instructors, and facilities and generate reports
publication of learning materials
provision of a course calendar
facilities to send learners messages and notifications
learner-learner and teacher-learner communication tools
assessment/testing tools
grading of coursework
display of results and transcripts
web-based or blended course delivery

Taking the characteristics of VLEs and the functions that they share it seemed that VLEs could provide the type of functionality that would support constructive pedagogy. However, there were far more characteristics than I required and the very wide range of functionality seemed to suit almost every conceivable pedagogy. I needed to somehow identify a way of more closely relating VLE functions with constructivist pedagogy I was using. This led to the use of a benchmarking approach to evaluate Bb.

I discuss this in the following section.

5.2.2 Framework for evaluating VLE
Fjuk (1998) have suggested a suitable framework for the evaluation of VLEs for business education. This framework uses Salomon's (1995) three interconnected elements:

- production/knowledge construction
- information sharing
- division of labour

The framework also considers both interactional and operational aspects using Vygotsky's (1978) perspectives. The interactional aspect focuses on the way knowledge is constructed both
individually and collaboratively. On the operational level the aim is to identify tools that enable the learner to achieve a specific outcome.

The following tables are based on this framework and relate the interactional and operational aspects to the VLE tools.

<table>
<thead>
<tr>
<th>Interactional examples</th>
<th>Operational examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Searching for information.</td>
<td>Digital libraries.</td>
</tr>
<tr>
<td>Constructing a personal domain of knowledge.</td>
<td>Mechanisms for constructing personal domains.</td>
</tr>
<tr>
<td>Articulating meaning into information objects (text, hypertext, notes etc).</td>
<td>Mechanisms for articulating thoughts.</td>
</tr>
<tr>
<td>Producing and distributing information objects.</td>
<td>Mechanisms to down(up)load objects.</td>
</tr>
<tr>
<td>Distributing and co-ordinating meanings to peers.</td>
<td>Mechanisms for attaching information objects.</td>
</tr>
<tr>
<td>Reflecting upon and elaborating on existing information objects.</td>
<td>Mechanisms for making notes Threaded discussions.</td>
</tr>
<tr>
<td>Identifying roles and tasks.</td>
<td>Mechanisms for allocation of roles.</td>
</tr>
<tr>
<td>(Re) evaluating own knowledge and interpretations.</td>
<td>Self-evaluating tools.</td>
</tr>
</tbody>
</table>

Table 5.9 - Production/knowledge construction (Fjuk, ibid).
This framework offered a comprehensive way for me to evaluate Bb as a potential tool for use in PISE. The next stage of this phase was to apply this framework to the Bb tool and see how suitable this VLE might be. This is discussed in the next section.
5.2.3 Applying the framework to Bb

Having identified the functions available in Bb it was then necessary for me to apply the framework developed by Fjuk to see how many of the operational examples could be identified with BB tools. This was done by considering each of the Interactional and Operational examples and mapping these to tools available in Bb. The following tables show the result of this process.

As can be seen in the third column the level of support for each of the stages of the framework is identified with a specific Bb functionality or tool.

<table>
<thead>
<tr>
<th>Interactional examples</th>
<th>Operational examples</th>
<th>Bb tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructing a personal domain of knowledge.</td>
<td>Mechanisms for constructing personal domains</td>
<td>Discussion boards</td>
</tr>
<tr>
<td>Articulating meaning into information objects (text, hypertext, notes etc)</td>
<td>Mechanisms for articulating thoughts.</td>
<td>Discussion boards, emails, personal web pages, file exchange.</td>
</tr>
<tr>
<td>Producing and distributing information objects.</td>
<td>Mechanisms to down(up)load objects.</td>
<td>Email attachments, file exchange, discussion boards postings.</td>
</tr>
<tr>
<td>Distributing and coordinating meanings to peers.</td>
<td>Mechanisms for attaching information objects.</td>
<td>Email, discussion boards postings, file exchange.</td>
</tr>
<tr>
<td>Reflecting upon and elaborating on existing information objects.</td>
<td>Mechanisms for making notes Threaded discussions.</td>
<td>Discussion boards.</td>
</tr>
<tr>
<td>(Re) evaluating own knowledge and interpretations.</td>
<td>Self-evaluating tools.</td>
<td>Discussion boards, whiteboard.</td>
</tr>
</tbody>
</table>

Table 5.12 - Production/knowledge construction and Bb functionality
<table>
<thead>
<tr>
<th>Interactional examples</th>
<th>Operational examples</th>
<th>BB tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distributing and co-ordinating information objects amongst peers.</td>
<td>Mechanisms that retrieve information from social interactions. Mechanisms that retrieve lists of all actors in the social communities and other actors in the system.</td>
<td>Email, whiteboard, discussion boards.</td>
</tr>
<tr>
<td>Commenting on information objects provided by peers.</td>
<td>Mechanisms that inform which actors are online. Synchronous and asynchronous mechanisms.</td>
<td>Discussion boards, whiteboard, Tutornet.</td>
</tr>
<tr>
<td>Co-producing/co-authoring information objects.</td>
<td>Mechanisms to retrieve whole dialogues with contributions. before and after that specified by actor.</td>
<td>Group discussion boards Tutornet log files.</td>
</tr>
<tr>
<td>Creating learners' content annotations.</td>
<td>Mechanisms for categorising dialogue items according to keywords.</td>
<td>None.</td>
</tr>
</tbody>
</table>

Table 5.13 - Information sharing/joint construction and Bb functionality

<table>
<thead>
<tr>
<th>Interactional examples</th>
<th>Operational examples</th>
<th>BB tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organising the group/project.</td>
<td>Mechanisms for producing joint information objects.</td>
<td>Group discussion board, whiteboard, group pages.</td>
</tr>
<tr>
<td>Articulating responsibility and commitments.</td>
<td>Minutes of meetings and decisions taken.</td>
<td>Group discussion board, file exchange</td>
</tr>
<tr>
<td>Articulating time for meetings etc.</td>
<td>Mechanism for using joint calendar facility.</td>
<td>Calendar tool.</td>
</tr>
<tr>
<td>Making common plans using responsibility/milestone charts.</td>
<td>Project management tools.</td>
<td>Calendar</td>
</tr>
<tr>
<td>Maintain awareness of how particular activity fits into individual's knowledge and progress.</td>
<td>Mechanism for retrieving an overview of individual's status.</td>
<td>Limited and not easily operationalised.</td>
</tr>
<tr>
<td>Maintaining awareness of learner's interaction with collaborative environment.</td>
<td>Mechanism to count number of interactions.</td>
<td>Limited and not easily operationalised.</td>
</tr>
</tbody>
</table>

Table 5.14 - Division of labour and Bb functionality (* Tutornet was an external service of
Nearly all of the interactional examples cited in this framework could be operationalised using one of the Bb tools or functions. However, in some cases the tools provided in Bb only offered a limited operational functionality. Nonetheless, the application of this framework in the benchmarking process indicated that Bb offered enough functionality to support the group-based approach to teaching and learning in PISE.

5.2.4 Group-based learning
A number of researchers (Sharan and Sharan, 1992; Slavin, 1997; Brush, 1998) have proposed five components of group-based learning:

- group size of between two and six
- positive interdependence which can be stimulated through tasks, resource, goals, rewards, roles or the environment
- genuine tasks that require the involvement of all group members
- individual accountability which refers to the students responsibility for a specific aspect of the group process
- a shift from teacher-centred to student-centred pedagogy

Sharan and Sharan (1992) have also suggested that it is necessary in many cases to use team-building exercises to develop effective group processing skills as many students would not have these. Two specific skills in this respect were identified to counter the negative effects of group-based learning, the ‘free-rider’ effect previously mentioned and group cohesion. These skills were ‘individual accountability’ and ‘positive interdependence’.

Individual accountability is actualised by rewarding each member of a team for their contributions. Positive interdependence can be achieved by designing tasks that require all of the different individual tasks in the final product. I was aiming to achieve both of these by the development of a marking scheme that rewarded each individual for their personal contribution and that required all individual contributions for the final report. This is discussed in more detail in the next chapter.
There are further difficulties associated with online groups. These mainly arise from the limitations of text-based communication and the lack of body language and tone of voice (Boetcher et al 1999). Lau et al (2000) found that teams that were ranked high in task focus with a low social dimension were very vulnerable to breakdown due to a lack of 'social glue'. They also found that once the group broke down it was more likely not to recover due to a lack of trust because of weak social bonding. The importance of strong relational links has been suggested by Walther et al (1992) as likely to lead to enhanced creativity, motivation and better decisions. Finally, Chidambaram (1996) found that because online groups are less effective in communication they are more task orientated and there is less 'social-emotional' information exchange.

So social cohesion was an important facet in determining the success of groups and one technique I used to encourage this was based on the idea of storytelling.

Denning (2000) points out the importance of storytelling in human society. She goes on to suggest that when a group shares in an individual's story, the individual experience can become the group's shared experience. This then further binds the group as an entity. This is often seen in face-to-face situations when humans are first meeting and establishing friendships. A shared experience can help to bond. Developing exercises requiring students to talk about their personal situations, to tell stories about themselves, was a technique I used in this study to further help in group building and bonding.

Research from social dynamics, and in particular small-group theory (i.e. based on groups of between two and six members), has revealed other variables that effect group interaction and performance. For example, an ability to regulate is a skill that is necessary for effective learning to take place in online, geographically dispersed learning groups. Benbunan-Fich and Hiltz (1999) have identified that this skill is one that students do not necessarily have and therefore some structure may be needed to help learners in this respect. Brush (1998) also identified that the lack of structure can impede overall group performance.
To achieve this structure a more formal problem or task needs to be introduced with clear guidelines as to what is expected from learners. This also became a focus of later cycles of research.

Configuration is another aspect that needs consideration in the design of geographically dispersed learning groups. O’Leary et al (2004) argue that this aspect is critical to the success of teams.

In their study O’Leary et al looked at 21 different configurations with varying numbers of geographically dispersed team members from each of four contributing sites. They discovered that the balanced teams, with equal numbers from each site, had the least amount of inequity among members and across work completed. Furthermore, teams that had the most unequal arrangement of members (e.g. N-1 members from one site and just 1 member from another) had the greatest amount of ineffectiveness in task completion. They also found that teams that had members from just two sites also had a higher level of dysfunction than teams from three or more sites.

I had discovered that having three institutions involved in this study had also produced the highest grades and best level of threaded discussion development. So the model I was using in terms of team size and number of collaborating institutions was the most likely to succeed, based on the published research.

5.3 Critical reflection on Cycle 1

This cycle of action research started the investigation into the main research question:

*Can the use of ICT enhance the learning experience of students working collaboratively in the domain of PISE?*

I initially investigated the use of ICT in teaching and learning. My aim was to discover if there was a theoretical basis for using ICT to support a group-based pedagogy. I also needed to identify what tools might be suitable without being in danger of damaging a student’s learning process.
During this second phase I applied theories of learning to the functional components of the Blackboard Virtual Learning Environment to confirm that this ICT could be used in PISE. The outcome of this phase was to identify Bb as the tool to use in this part of the study.

In the next phase in this cycle was I developed a web-based course site using Bb and evaluated student use.

My findings were that the use of Bb dramatically improved the management of a large cohort of learners in PISE. It also indicated that there might be some positive benefits to the learning experience by students. But my students alerted me to the inauthentic nature of using the VLE for online discussions when the cohort was from a single institution. This led to phases of research to explore the use of a multi-institutional approach to collaboration.

Following the identification of suitable partners, a first multi-institutional collaboration took place between UL and SHU. The outcomes from this phase indicated that there was a potential benefit to learners (and faculty!) in using this methodology in PISE. Feedback from students also suggested that there was a positive response to the pedagogy being developed and also towards the use of Bb.

I conducted and evaluated a further teaching and assessment cycle, but with three institutions this time, adding DMU to the collaboration. Once again there were demonstrable improvements in some measures of learning achievement. Students also seemed to enjoy the learning process. I had also identified an authentic reason for using ICT to support teaching and assessment in PISE. Once again there was positive feedback from students on the pedagogy and the tool being used.

The outcomes from this cycle encouraged me to consider how to progress my research. I realised it would be necessary to develop tools to better measure learning and that could help to answer my fundamental research question.

However, as part of the critical reflection on this cycle of the research I had also identified some specific problems. One was the ongoing difficulty in the way students used the bulletin board for
discussion. I therefore produced guidelines to help learners with this problem as a further outcome from this cycle. This is now discussed below.

5.3.1 Using bulletin boards
A major issue that I had identified in using VLE for online collaboration was a problem students seem to have in using discussion boards effectively. This was manifested in the lack of development of threaded discussion and also the way in which some learners posted to the discussion board. I discovered that none of these skills were being taught in any of the other modules in the degree programme and I decided that formal teaching input as part of PISE would be required to deal with this situation.

I therefore developed the following advice on using bulletin boards following a meeting with a focus group of students I established to look at this problem.
**Using a bulletin board (also known as a discussion board)**

A bulletin board (BB) represents a virtual discussion. Consider what you would do in a face-to-face (f2f) discussion.

Imagine a group of people, A,B,C.

A makes a point and B responds to A.  
C also wants to respond to A's point so directs her comments to A.  
B wants to respond to C so she directs her comments to C (not A).  
A wants to respond to C's comment so directs her point to C (not to anybody else). Etc, etc.

In a virtual discussion you should also be aware of who you are responding to. Don't just reply to the most recent posting but ensure that your reply is directed at the person who made the initial point. (It may be necessary to post more than one message if you want to respond to more than one person. This is just like in a f2f conversation. You talk to one person and then switch your attention to another person to talk to them.)

The second point about virtual discussions concerns how you respond. There is one way of responding if you are continuing an on-going discussion and another way if you are introducing a new topic.

- Use the 'Reply' button if you wish to answer a query or respond to a point that somebody else has made.  
- Start a new thread if you are introducing a new topic.  
- If necessary post two or more different messages if you want to address a number of different points

Before you post anything, prepare it off-line. Check for spelling and syntax mistakes. Keep it short and to the point. Ensure that you have included appropriate references. Don't just post the first thing that comes into your mind. A knee-jerk reaction may be OK in f2f conversations but looks superficial and ill thought out when seen on a BB. Be careful about using the personal opinions of journalists or TV presenters. They may not be objective.

All postings should be the subject of your research. **You will not get marks for giving personal opinions.** So if you are involved in a discussion about the legal aspects of a scenario then each posting should refer to specific laws or statutes that might be relevant. Responses should then focus on other laws that might be relevant, e.g., who is responsible when a piece of software is implicated in the death or injury of somebody? Is it the user, were they negligent in the way it was used? Is it the software house, did they take short cuts in the testing. In either situation different laws may be used to prosecute or to claim compensation. This should be your focus.

![Figure 5.4 Guidelines for using bulletin boards](image-url)

<table>
<thead>
<tr>
<th>5.3.2 Other guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>I also produced a new overview for students to deal with other issues (Appendix6_2) that had been</td>
</tr>
</tbody>
</table>
identified in this cycle. This overview focused and gave guidance on the following points:

- establishing groups and socialising
- organising and roles in groups
- planning and management issues
- discussion threads and how they influence achievement of higher-order critical thinking
- asynchronous tools use
- monitoring by faculty
- document versions
- use of attachments

This was made available to students in later phases.

5.3.3 Proposed update to Bb functionality

Although the introduction of a Bb server at UL had removed some of the access problems, there was still an ongoing issue with the design of the Bb VLE.

As was discussed previously, the cumbersome way Bb used for accessing Discussion Boards meant that as many as five levels of navigation were necessary to read or respond to a post. I felt that some sort of alerting system would improve this. My idea was that an email might be generated each time somebody posted to a discussion board and sent to all subscribers of the board. This would reduce the number of times a user accessed a board only to find no new posts.

I formally requested that the Bb team look into this as a functional upgrade to their software. Unfortunately this did not happen with the remaining licence period. However, I had then discovered another VLE which is discussed later.
5.4 Conclusion to cycle 1

The research had developed in this cycle to include a multi-institutional collaboration. I was able over a three-year period to move from a single institution study to collaboration first with two universities and then with three.

Having identified from student feedback and observation of student activity some further problems, I developed further guidelines and approaches to using this pedagogy. I would assess these in future phases of the research.

The use of Bb facilitated this international collaboration and some very encouraging trends continued to emerge.

However it became obvious to me that the measures being used to assess enhanced student learning were at best very crude. This was the main reservation I had from conference presentations feedback. It was an important issue. So I was also considering during this cycle other methods of measuring learning. I still needed to consider how I could measure enhancement of learning.

Enhancement could be defined as an improvement in higher-order critical thinking skills and I needed a less crude way of assessing this than I had been using so far. This led to a simultaneous, but separate, strand of research: an evaluation and use of tools to measure changes in learning. I discuss this in the following chapter as the next cycle of research.
6 Cycle 3 Identifying effective tools to measure learning

6.1 Personal narrative on Cycle 3

My core research focus was on the effectiveness of using ICT to enhance learning in PISE.

Although I had some anecdotal evidence as reported in the previous chapter that this might be the case, I was not satisfied that measuring page hits or using assignment grades confirmed this.

As was mentioned in Chapter 5, the nature of this research meant that I could only conduct empirical studies once per academic year, the frequency in which PISE was delivered. It was therefore necessary to have more than one strand of research taking place simultaneously. Although the research period covered in this cycle overlaps that covered in Chapter 5, in this cycle I have focussed on the research issues surrounding measurement of learning. The following diagram illustrates the phases of Cycle 2.

![Figure 6.1 Phases in Cycle 2.](image)

The first phase examines tools used to measure development in moral reasoning. The second phase focuses on the use of one such too, the Moral Judgment Test (MJT). The third phase concerns an
alternative instrument to measure critical thinking in online discussions, the Community of Inquiry.

The fourth and final phase describes how I used this tool.

There then follows a literature review of research associated with the phases in this cycle. The chapter concludes with a critical reflection on the research questions under investigation in this cycle.

6.1.1 Phase 2.1 Measuring moral reasoning development

In this study I intended that learners would be encouraged to analyse a moral dilemma, evaluate different moral solutions and create a personal moral code of practice by adopting a collaborative, group-based approach to learning. The previously discussed teaching phases where students used Blackboard (Bb) to support their group-based learning seemed to suggest that using ICT to support the pedagogy enhanced their learning. But my strategies of data collection and analysis did not give me confidence in using page hits and/or assignment grades to measure enhancement of learning. This, therefore, led me to another phase in the research, an investigating of other techniques to measure learning in PISE.

6.1.1.1 Overview

As was seen earlier, PISE is in part about the ethical consequences of the design, development and use of computer and information systems. Fundamental to this is the necessity that professionals who had graduated from a degree incorporating such a module, would have the required level of moral reasoning to respond to ethical consequences of their work. Moral reasoning ability was therefore a core learning outcome of PISE.

So I decided to examine techniques that measure moral reasoning development and ethical analysis as a basis for measuring student learning. I also wanted to see if there was evidence that analysing moral dilemmas can contribute to the attainment of higher-order learning outcomes and development of critical thinking skills, a previously mentioned outcome of third level learning.
6.1.1.2 Research Methods and data gathering

I conducted a literature review to determine if there were any techniques or instruments that could be used to determine the achievement of learning in PISE, and specifically computer ethics. My research identified two instruments that had been developed to objectively measure moral reasoning development. I investigated and compared these two instruments and I then made a decision as to which one to use.

I continued to keep my personal journal updated and recorded student feedback and personal observations.

6.1.1.3 Analysis of data and critical reflection

My research of the literature identified two dominant instruments that had been developed and extensively used for measuring moral reasoning development, the Defining Issues Test (Rest 1979) and the Moral Judgement Test (Lind 2001). The MJT was a development of Kohlberg’s (1964) Moral Judgement Interview.

I conducted a further review of the literature on both of these tools and this is discussed more fully in section 6.3 below. Here I briefly discuss my findings.

I needed to be sure that whatever instrument I selected was easy to use. My research had shown (Gielen et al, 1994 (cited in Lind 2000), Self et al, 1992) that the DIT questionnaire was overly long and quite complex with up to 50% of unscorable cases. This potential difficulty in getting meaningful data was of concern to me for two reasons:

- I was not sure how my students would respond to such a tool
- it would also be more difficult to administer

A further consideration was the ability to fake results, particularly whether subjects could fake their moral reasoning level upwards. As early as 1983 Emler et al had identified that the DIT outcomes could be faked. However, in another study Wasel (1994, cited in Lind 2005) showed that moral
judgement competence when measured by MJT could not be faked upwards. So in considering which of these instruments to use the MJT appeared to be the more reliable.

Elm et al (1994) compared the DIT with the Moral Judgement Interview (the forerunner of the MJT developed by Kohlberg). They reported that ‘it is likely that the DIT credits subjects with more advanced reasoning than Kohlberg’s method does’. In other words, there was a further potential problem of reliability with the results of the DIT.

The issue of what is being measured was also important. The MJT assessed the degree to which subjects were consistent in the way they rated a number of statements according to their moral standards. According to Lind (2001) the C-index computed with the MJT reflected a ‘person’s ability to judge arguments according to their moral quality (rather than their opinion, agreement or other factors)’. By use of pro and con statements it was therefore possible to use the C-index to measure an person’s ability to consistently apply their moral principles to a moral dilemma. It was also argued that this instrument particularly identified those with ‘mature cognitive structures’. And these structures were, coincidently, the same as those that were exhibited in higher-order critical thinking.

A final factor that inclined me towards the MJT was that it was designed specifically as a tool for research into the effect of educational input into moral learning. It was designed to specifically produce robust results when used with groups of subjects and this resonated with my desire to explore the group-base approach to learning in PISE.

With these findings I therefore decided that I would use the MJT as a means of measuring moral reasoning development in the context of the multi-institutional collaboration. As this was a core aim of my research my hope was that the MJT might tell me something about this.
6.1.2 Phase 2.2 Using the MJT to assess learning

6.1.2.1 Overview

As has been mentioned already, I was concerned as to whether the methods I was using to measure student learning answered my research question. Did ICT enhance the learning of students in PISE? I had collected student feedback that indicated this might be the case. I had also collected data on student grades and the growth of threaded discussions, which also indicated a positive trend. But I was not convinced that I could stand over my interpretation of these results. I therefore decided to see if the MJT could provide better ‘claimsmaking’ (Knight, 2002).

6.1.2.2 Research methods and data gathering

The MJT questionnaires were distributed during the first and final lecture slots in the courses. Students were asked to fill out their responses in the lecture room and then forms were collected. This was carried out in each of the three universities. Questionnaires from DMU and SHU were posted to me for data analysis.

The test administration states that the test should take ‘approximately 10 to 20 minutes to fill out’ and this was the case for both pre and post-module implementation. However, in some instances students who were absent from the initial or final lecture filled out the test papers in their own time. This may have affected subsequent results. Some students did not complete either the pre and/or the post-module questionnaires. Students who did not submit both the pre and post MJT papers had their C-index eliminated to avoid skewing the results. Table 6.1 below shows the number of completed test forms for all situations.

<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>de Montfort</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Limerick</td>
<td>100</td>
<td>117</td>
</tr>
<tr>
<td>Sacred Heart</td>
<td>12</td>
<td>11</td>
</tr>
</tbody>
</table>

Table 6.1 Completed MJT forms.
The tests papers were then analysed according to the formula developed by Lind (1986). See Appendix 6.3 for this. This involved a complex calculation for each pair of test papers. Figure 6.2 below is a screen dump of the test calculation as a spreadsheet macro.

I had over 100 pairs of tests to analyse, each with 24 inputs!

So, back to the power of the computer. I wrote a computer program in C++ that would take the 24 input values of each form and calculate the C index. Although it took a few days to complete, it was worth it as I was going to use the MJT in more than one teaching cycle.
6.1.2.3 Analysis of data and critical reflection

In order to avoid individual differences due to external factors such as fatigue, illness, emotional state etc., the MJT C-index differences were calculated for each pair of completed test papers and these differences were then averaged for each group (Lind 2002). A positive mark of >5 indicates that there has been a measurable improvement in moral reasoning for the group while a negative mark indicates an erosion of moral reasoning competence.

Figure 6.3 Single (UL only) institution MJT averages.

Figure 6.3 above shows the results for UL only groups, i.e. groups with only UL students, the control. The X-axis shows the C-index scale. The bar graph shows the C-index difference between pre- and post-test questionnaires. 16 groups completed these. As can be seen 11 groups had an increase of >5 and 5 groups showed a decrease of >-5.

Figure 6.4 Multi-institution MJT results
In multi-institution groups only a single group showed an increase >5 and four showed decreases => -5.

Single institution groups scored higher on average (3.9) than multi-institution groups (-0.12). However as neither score is greater than 5 little significance can be attributed to these. Furthermore, a higher percentage of single institution groups achieved positive C-index differences between the pre- and post-test conditions than was achieved by multi-institution groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>Country</th>
<th>N</th>
<th>Completed MJT tests</th>
<th>C-index average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Int 1</td>
<td>Irl</td>
<td>2</td>
<td>2</td>
<td>3.25</td>
</tr>
<tr>
<td></td>
<td>UK</td>
<td>1</td>
<td>1</td>
<td>37.71</td>
</tr>
<tr>
<td></td>
<td>US</td>
<td>2</td>
<td>1</td>
<td>-25.5</td>
</tr>
<tr>
<td>Int 2</td>
<td>Irl</td>
<td>1</td>
<td>1</td>
<td>-7.3</td>
</tr>
<tr>
<td></td>
<td>UK</td>
<td>2</td>
<td>2</td>
<td>-3.97</td>
</tr>
<tr>
<td></td>
<td>US</td>
<td>2</td>
<td>2</td>
<td>1.37</td>
</tr>
<tr>
<td>Int 3</td>
<td>Irl</td>
<td>4</td>
<td>4</td>
<td>12.83</td>
</tr>
<tr>
<td></td>
<td>US</td>
<td>1</td>
<td>1</td>
<td>1.24</td>
</tr>
<tr>
<td>Int 4</td>
<td>Irl</td>
<td>2</td>
<td>1</td>
<td>8.13</td>
</tr>
<tr>
<td></td>
<td>UK</td>
<td>2</td>
<td>2</td>
<td>-10.47</td>
</tr>
<tr>
<td></td>
<td>US</td>
<td>1</td>
<td>1</td>
<td>-17.43</td>
</tr>
<tr>
<td>Int 5</td>
<td>Irl</td>
<td>2</td>
<td>1</td>
<td>5.23</td>
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<td>US</td>
<td>2</td>
<td>2</td>
<td>-13.53</td>
</tr>
<tr>
<td>Int 6</td>
<td>Irl</td>
<td>2</td>
<td>2</td>
<td>-1.1</td>
</tr>
<tr>
<td></td>
<td>UK</td>
<td>2</td>
<td>2</td>
<td>-2.79</td>
</tr>
<tr>
<td>Int 7</td>
<td>Irl</td>
<td>2</td>
<td>2</td>
<td>7.22</td>
</tr>
<tr>
<td></td>
<td>UK</td>
<td>2</td>
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<td>-1.67</td>
</tr>
<tr>
<td></td>
<td>US</td>
<td>2</td>
<td>2</td>
<td>0.82</td>
</tr>
</tbody>
</table>

Table 6.2 Breakdown of C-index scores by country.

Table 6.2 shows a breakdown of the C-index scores for each multi-institution group by nationality. It also shows the average scores achieved by students from each country and the number of completed (pre and post) MJT questionnaires.

It can be seen that the averages varied within groups, and across national representations. It should also be noted that not all students from a specific institution in a group completed the pre and post-test questionnaires. In all only 9 averages could be taken where n>1. As a result, there was little valid analysis that could be applied to these results. However, I needed to determine why this had
happened and whether it was an intrinsic problem of the tool or something that I could sort in future phases of research.

6.1.2.4 Difficulties that might have impacted the results of the MJT

The first issue I investigated concerned the level of importance students gave to the completion of the MJT questionnaires. The results in Table 6.2 show that in Int 1 one student achieved an increase of 37.71 while another student in the same learning group had a score of -25.52, a dramatic decrease in moral reasoning. This decrease in ability is highly implausible, and wide differences in intra-group scores are also highly improbable. I therefore met with a focus group of students to discover the reason for this type of outcome and to get their feedback on the MJT test. The following are some comments from my journal that reflect the majority view.

‘I couldn’t see the point of the MJT questionnaire’

‘Why did we have to fill this out twice? We did it once already and the second time seemed a waste of time.’

‘To be honest I just put anything in the form. It was the last thing we had to do in the last lecture and I wanted to get to the Stables [UL pub]’

‘There were no marks for this so I didn’t really bother to do it properly’

‘I found some of the statements difficult to understand. I think I was better able to do the form the second time.’

Furthermore, Gommel et al (2006) have discovered a similar trend with medical students. They report ‘the [C-index] data indicate a sharp decrease of moral judgment competence in spite of two semesters of ethics training’.

There was a further problem in that I was not able to control the manner in which the MJT process was conducted in SHU and DMU. Although my collaborators conducted the test according to the
instructions, there was always the possibility that other variables could affect the attitude of students from these institutions.

I therefore came to the conclusion (supported by this kind of evidence) that the C-scores I was getting could not necessarily be trusted. In order to overcome this in a future iterations of the study, I introduced methods to, hopefully, deal with these issues.

6.1.2.5 A second attempt at using the MJT

As was discussed in Chapter 5, my two partners at SHU and DMU were keen to continue the collaboration and we again set up a further collaboration in the following academic year.

Again the same design was used but I also adopted a new strategy for the MJT. In this iteration I decided that I would apply the MJT analysis only to UL students, as I would be more able to control the way they interacted with the MJT process. For the analysis I divided the students into two groups, one consisting of those who were in ‘international’ groups and another who were in UL only groups.

As a result of the feedback from the previous iteration, I also wanted to get my students to take seriously the completion of the MJT forms. I therefore decided to adopt two strategies that I hoped would deal with this issue.

Firstly, I emphasised the importance of the MJT by rewarding students for completing both the pre- and post-module questionnaires. These marks, although only 5% of the total, had the desired effect and there was a completion rate of almost 70% this time. (To ensure that those who genuinely couldn’t complete the forms in the observed situation were not unfairly penalised, I also allocated marks to these students if they submitted the completed questionnaires, but did not use their MJT scores in my analysis, as I would not have been able to control the time they spent or other variables.)
The second strategy I adopted was to fully discuss with my students why I was undertaking this research. I explained that it was to enable me to enhance the learning for all who were, and would in future, be studying PISE. I also explained that my aim in using the MJT was to assess its effectiveness in determining if learning was enhanced by this multi-institutional online collaboration. As I have already discussed in Chapter 3, the action research links research theory context and does this by involving all stakeholders in the process. My belief was that by adopting this strategy students would act more responsibly and be serious in completing these questionnaires.

Following analysis of the pre and post-module questionnaires using the MJT scoring scheme, the C-index averages for UL students and ‘international’ students were calculated and compared. The results showed a small but not significant difference between the two group. This difference was less than 5 so although it demonstrates a trend it does not unambiguously indicate that there has been increased improvement in moral reasoning for ‘international’ students, as measured by the MJT.

So what if anything can we learn from these results?

Firstly that there is an apparent greater improvement in moral reasoning development as measured by the MJT when learners participate in geographically dispersed virtual learning groups when compared with the results achieved by learners in single institution groups. Secondly, that there is a greater measure of improvement for female students than for male students. This may well be to do with the fact as indicated in some research studies that females are more likely to collaborate whereas males are more likely to compete.

Or perhaps the results were just anomalous.

I used the MJT again in future cycles of teaching and research but results continued to be ambiguous. The discrepancies in individual C-index scores between group members continued to be problematic, although the very wide differences in the first use of the MJT were reduced. This led
me to doubt the usefulness of the MJT in measuring the effectiveness of educational intervention in this study.

I believe now one reason for this is that a single semester is just not long enough to make meaningful difference to a students’ moral reasoning. Research (Colesante et al, 2001) have noted that ‘the C-index hardly increases from freshman to senior year, indicating the college education has no impact on the development of moral judgment competence’. One possible solution is to conduct a longitudinal study where students from both single- and multi-institutional groups take a further MJT some years after completing the module. This may then be a better measure of moral reasoning development, but other factors may then be responsible for individual moral reasoning development, not the learning situation of which the student had been part.

Chiharu (2006) also suggests a reason why the MJT (and the DIT) ‘reflects a more absolutistic ethics, which hardly describes real-life decision-making’ and goes on to argue that

*It is rare that we encounter a situation in which only one ethical principles is invoked and, therefore, possible to ignore any other principles. Strict deontological ethics (as Kant seems to believe in) offers no solution for situations in which two or more principles involved require opposite courses of action.*

So perhaps the use of the MJT, while having some validity as an instrument that can measure moral reasoning development, does not work in the context in which I was using it.

### 6.1.3 Phase 2.3 Community of Inquiry

#### 6.1.3.1 Overview

The MJT was one method of measuring learning but as the outcomes of this approach seemed questionable after the first collaboration (and continued to be so in later cycles of teaching and research), I simultaneously investigated other methods.

My review of the literature showed that there was another body of ongoing research into methods of assessing learning in online discussion groups. I therefore began to focus on a method called the Community of Inquiry (Archer et al, 2001, Garrison et al 2001), which is now discussed.
6.1.3.2 Research methods and data gathering

As was discussed in Chapter 3 a fundamental component of action research is the need to get feedback from the community of researchers in a given area. It is this feedback that enables the researcher to distinguish action research from good professional practice. My strategies of data collection and data analysis had not given me confidence in the interpretation I was developing. I was not convinced that the way I was measuring enhancement of learning was telling me anything about the effects of the pedagogy I was adopting. I was not sure I could stand over my research findings and say that this approach was better for my students than the alternatives.

I therefore discussed my misgivings about the MJT at various conferences and with both of my collaborating partners. This helped to identify features that were important in determining learning improvement. I received many suggestions for alternative methods of assessing development of critical thinking in online discussion groups and identified a number of different instruments and frameworks.

A comprehensive review of the literature identified over 27 different types of tool that were being used to assess online learning. I read numerous papers on these tools but I was struck by the Community of Inquiry (CoI) (Garrison et al, ibid), which is more fully discussed in section 6.3 below. This is now discussed.

6.1.3.3 Analysis of data and critical reflection

As will be seen from the discussion in the Literature review below (6.3) the CoI proposed that an important perspective in assessing learning in online communication was Cognitive Presence (CP). CP is defined as ‘the extent to which the participants in any particular configuration of a community of inquiry are able to construct meaning through sustained communication’ (Garrison et al, 2001).

CP is determined by the categorisation of each post in a discussion board in one of four ways:

- Triggering
- Exploration
• Integration
• Resolution

The following are examples of the different categories of posts:

Triggering

*I think this is important, as it states exactly what we need to focus on... but I can't figure out the implications of this... please help! Do we just consider the situation BEFORE the bug was fixed?*

Exploration

*In the ten commandments on Computer Ethics by the Computer Ethics Institute, the following is rule number 7. 'Thou shalt not use other people's computer resources without authorization or proper compensation.' In the Scenario would this imply that the consortium were unethical as they made amendments to Entwhistle's product without authorization? What do you all think?*

Integration

*Okay, let me explain. Firstly to recap, what exactly is a patent? 'A patent is an exclusive right granted for an invention, which is a product or a process that provides a new way of doing something, or offers a new technical solution to a problem.'*

Resolution

*So far, this is how I have interpreted this thread... We all agree that the consortium modified and distributed Entwhistle's patented product and as such they did break the patent. BUT we are arguing that the exception quoted above protects the consortiums actions and hence no breach legally took place.*

Before using these four categories to analyse the data a further consideration needed to be given to the unit of analysis. This can be defined as the discrete element of data that enables text to be identified, categorised and recorded for analysis. There are a number of possible levels which can be used, from syntactical units such as phrases, sentences and paragraphs to thematic units. Garrison et al identified that the most appropriate unit of analysis was the message or posting as this combined ‘the flexibility of the thematic unit, which allows coders to capture a unit in its natural
form, with the reliable identification attributes of a syntactical unit’. In this study I have used the same unit of analysis.

Having identified CoI to measure learning it was necessary to discuss with my students how this would be used. I therefore published the following, including an extract from the Garrison research paper, which I felt would help students categorise the type of posts they were adding to the discussions. I believed that this would encourage them to produce higher-level posts.

### Analysis of cognitive presence

I am trying to identify the best way in which to teach and assess PISE. As you already know one approach is the use of Bb for online discussion and the ‘international’ collaboration. But I also want to ensure that the marking of your work is objective, that there is no favouritism for example. One way to achieve this is to make sure you understand the way in which your posts are assessed. The following is the Community of Inquiry method of categorising posts. Please take some time to read it and we can discuss it in the lecture if you have any concerns or questions.

There are four categories in the cognitive presence element within the model proposed for the analysis of critical thinking and practical enquiry (Garrison et al, 2001) These are:

- triggering events
- exploration
- integration
- resolution

(This was then followed by the table 6.12 which is shown in section 6.3 below.)

If you post more Triggering posts than Resolution posts, my previous research indicates that you might not do so well on the report grade. This is not a proven correlation but is a likely correlation. So try and post more of the integration and resolution posts and less of the triggering or explorations posts.

Remember that you are also part of a team and that posting smaller messages more frequently will help your other team mates to discuss and debate. Don’t just post one 1500 word post at the end of the discussion.

Figure 6.5 Initial guidelines to students for posting to discussion boards.

This, once again, was a feature of the action research methodology I was adopting, getting all stakeholders involved and breaking down the barrier between the researcher and the researched.

I was now ready for the next phase, using the Cognitive Presence to assess the online discussions.
6.1.4 Phase 2.4 Using Cognitive Presence to assess student learning

6.1.4.1 Overview
The Community of Inquiry (CoI) framework offered an alternative method to assess online discussions. I therefore used this instrument, and more specifically the measure of Cognitive Presence (CP), for evaluating each post while continuing to use and evaluate the MJT.

6.1.4.2 Research methods and data gathering
Seven groups of students from the three institutions were established with 6 members in each. Each group discussed a moral dilemma case study online using the Bb group discussion board tool and then submitted a written report for assessment based on the contents of the threaded discussions. Marking was carried out independently by each of the tutors and following some minor adjustments the marks were agreed for each group.

I then decided to see if the application of the CP categorisation on posts correlated in any way with the grades awarded. I later re-read each post and allocated it to one of the four CP categories. I allowed a period of several months to elapse so that my recollection of the grades awarded to each group would be diminished and less likely to influence how I categorised individual posts. Although not foolproof I feel that this method did enable me to develop some belief in the usefulness of this instrument.
6.1.4.3 Analysis of data and critical reflection

Following the categorisation of the posts I compared the number and type of posts to the mark that had been awarded several months previously. The following table show this analysis.

<table>
<thead>
<tr>
<th>Group ID</th>
<th>Triggering</th>
<th>Exploration</th>
<th>Integration</th>
<th>Resolution</th>
<th>Total Posted</th>
<th>Mark awarded %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>28</td>
<td>36</td>
<td>7</td>
<td>74</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>21</td>
<td>51</td>
<td>7</td>
<td>82</td>
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<td>3</td>
<td>5</td>
<td>35</td>
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<td>112</td>
<td>78</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>12</td>
<td>8</td>
<td>1</td>
<td>22</td>
<td>50</td>
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<td>5</td>
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<td>8</td>
<td>3</td>
<td>0</td>
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<td>31</td>
<td>9</td>
<td>10</td>
<td>56</td>
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</tr>
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<td>7</td>
<td>10</td>
<td>22</td>
<td>13</td>
<td>3</td>
<td>48</td>
<td>52</td>
</tr>
</tbody>
</table>

Table 6.3 Analysis of postings.

As can be seen from the above table, group 3 received the highest scores of any group, and this also correlated with the time they spent using Blackboard as a tool to sustain communication about their project.

It can also be seen that the data shows a broad correlation between the marks awarded and the occurrences of messages in the integration and resolution categories. Groups who received higher grades in recognition of their problem analysis and solution were assumed to have achieved higher levels of critical thinking. The results of the analysis of CP, and particularly the occurrence of messages in the integration and resolution categories, appears to highly correlates with the grades awarded and points to the fact that that there is a link between the use of this collaborative approach and the development of critical thinking skills.

There were, however, some problems. Some of the posts were overly long and contained a number of different messages making them difficult to assess with 100% confidence. I therefore identified the highest category that I could assign to these posts and that was the eventual recorded CP category.
I felt that further advice and guidelines needed to be developed for students so that they could produce more assessable posts. Or as previously discussed, the unit of analysis was appropriate length and contained only a single theme or concept.

6.1.5 Phase 2.5 A second use of the CP to assess individual posts

The first use of CP to assess learning showed a correlation between the categorisation of posts and the grades awarded by the independent marking of the reports. This boded well for the use of CP as a way of measuring student learning. However, it was important that I determined that this was not just chance or luck, that there was validity in this interpretation of the CP.

It was, however, necessary to update the guidelines I gave to the students. Feedback had shown that some were confused about how to post higher-order (in CP terms) posts and that the importance of having smaller but more frequent posts needed emphasising. I therefore spent some time developing further guidelines for learners in the period between the two cycles of collaborations.

The first issue was to determine the appropriate size of messages. Overly long posts would only get a single grade and posts that were too short may not contain any meaningful information to progress the discussions. Furthermore, the CP method identified the need for each post to have an identifiable component to allow for categorisation.

Dabbagh (2002), Dabbagh et al (2004) have suggested that small amounts regularly posted will positively contribute to development of discussion threads. She determined that 1 to 2 paragraphs, about 150 words, is a useful size. Other researchers (Dillenbourg, 1999, Hogan et al, 1997) have argued that scaffolding can help to develop learning. However for scaffolding to be useful knowledge must be presented in 'chunks', with each chunk allowing for feedback.

From earlier iterations of the teaching and assessment cycle, as was discussed in Chapter 5 (section 5.1.3.3), indeterminate periods for online discussion may have contributed to students being more lax in getting involved. Shorter periods did not allow time for reflection on other posts and suitable
responses to be researched and added to the discussion. I had therefore determined that a three-week period for online discussion was appropriate. But I also needed to consider the minimum weekly level of words.

The module assignment required each student to produce about 1000 words for the final report (each group of six producing 6000 words). There needed to be a relationship between the number of words produced in the posts and the size of the final report because some students submitted all or part of the threaded discussion as the main part of this report. That meant about 330 words per student per week. Applying Dabbagh’s (2002, 2004) recommendations of about 150 words per post meant that each student should post twice per week.

It became obvious that this level was sometimes too little to allow meaningful discussion of the ethical dilemma and I therefore increased this limit. Increasing the number of posts to three or more per week allowed for the development of discussion threads. I therefore determined that around 450 words per student per week would be suitable constrained to about 150 words per post. This would have the following advantages:

• allow for meaningful discussion to develop
• produce messages that could be more easily categorised using CoI
• aid with scaffolding

The guidelines I developed were provided to students and can be seen in Appendix6.2. My intention was that these guidelines would encourage the learners to post more frequently and posts would be of a higher quality. If learners were producing higher quality posts then this should be a reflection of higher-order critical thinking.

This is now discussed.
6.1.5.1 Research methods and data gathering

Six groups were established each with six members. I again categorised the posts using the CP methodology and I also made this available to students in the form of feedback. Following the assessment of the final module assignment reports I then compared the CP categorisation with the marks that had been awarded.

6.1.5.2 Analysis of data and critical reflection

Table 6.9 below shows the CP categorisation of posts and the marks that had been awarded to each group for the final report based on their online discussions.

<table>
<thead>
<tr>
<th>Group ID</th>
<th>Triggering</th>
<th>Exploration</th>
<th>Integration</th>
<th>Resolution</th>
<th>Mark awarded %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>20</td>
<td>12</td>
<td>0</td>
<td>33*</td>
</tr>
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</tr>
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<td>8</td>
<td>20</td>
<td>21</td>
<td>5</td>
<td>61</td>
</tr>
</tbody>
</table>

Table 6.4 International groups analysis of postings (* 10 marks deducted for late hand in)

As can be seen there is again a strong correlation between those with the highest number of resolution posts and the marks awarded. This confirmed the trend observed in the previous phase but it was achieved with lower number of posts.

Groups 1 and 5 both have zero resolution posts but far different marks. However when the penalty for late submission is removed the marks are 43 and 53 respectively. Again a large disparity in the total number of posts can be seen between these two groups, indicating less online activity with Group 1.

My overall analysis of this data was that once again, at the group level, there was a positive correlation between the marks awarded and the CP analysis and that limiting posts did not have an adverse effect of the CP categorisation and the overall standard of completed assignment.
6.1.5.3 Student feedback

I collected feedback from students on the use of the CP framework. The following are some comments recorded in my personal journal.

‘It was useful to see how we were doing in our postings.’

‘I found it difficult to get the level right for the posts’

‘The information you gave was confusing, it was difficult to relate the messages in the case study to the descriptions in the table you gave’

‘Not sure I understand what the CP thing does or how it works’

These were typical comments, a recognition of the usefulness of feedback in the form of categorisation of posts but also some difficulties. These were mainly focussed on understanding the relationship between the different categories and the types of posts I was looking for as a module tutor. In succeeding cycles of teaching and research I further developed the CP categorisation to reflect more directly the types of posts typical to PISE and to provided more guidance to students as to how they could increase the number of higher-level posts. These developments are discussed in Chapter 7.

Feedback from learners helped me to develop a method using the CP categorisation where students were able to engage in meaningful online discussion and, at the same time, produce posts that contributed to higher grades. However, there were further issues that needed address, and as is the nature of the action research approach I was adopting, these were focussed on in the next cycle of research.
6.2  Justification from the literature

In this section I discuss the research relating to this cycle of the study. I start by discussing the tools used to measure moral reasoning development and why I selected the MJT. I then continue with a discussion of the CoI and the CP categorisation of posts in online discussions.

6.2.1  Two tools to measure moral reasoning development

6.2.1.1  The Moral Judgement Test

Lawrence Kohlberg (1964, 1984) had proposed one approach that might be used to measure moral reasoning, the Moral Reasoning Interview. He based this instrument and his stage theory of moral development on the work of Piaget (1965/1932). Kohlberg believed that the ability to reason according to universalisable moral principles and act in accordance with these principles was important. He also believed that action on our principles was part of the definition of moral behaviour, there could be no separation between hypothetical theorising and real moral action.

Piaget had already proposed his two-stage model of moral development. He found that when children under 10 or 11 years were thinking about moral dilemmas they regard rules as fixed and absolute. Children in this age group also base their moral decision making on a consideration of the consequences of their actions and also believe that rules are handed down by authority figures such as God or parents and cannot be changed. As the child gets older he or she develops a more relativistic view in which rules are seen as being possible to change and as being there only to enable humans to behave cooperatively. Older children also base their judgments on intentions.

An example illustrates this two-stage theory.

A child hears about two boys, one who broke a large number of cups trying to help his mother, and another who broke only one cup trying to steal biscuits. The younger child will typically think that the first boy behaved worse. The younger child focuses on the amount of damage that was caused, and the consequences, whereas the older child is more likely to assess the level of wrongness in
terms of the motives underlying the act (Piaget, 1932, p. 137). According to Piaget's theory of
development, the child of age 11 to 12 enters the general stage of formal operations of intellectual
development.

Kohlberg also believed that people progress through a series of stages in their moral reasoning
development. But unlike Piaget he believed intellectual development doesn't stop at 12. In his
research, Kohlberg interviewed children older than those in Piaget's study to see if there were more
stages of moral reasoning than the two proposed by Piaget. This work eventually led to Kohlberg's

Kohlberg (1963, 1970) sampled young adults from a variety of backgrounds and cultures aged
between 10 and 16. The subjects were presented with a series of ethical dilemmas and then
extensively interviewed. The interviewer focused on the reasons behind answers in order to get an
understanding of the subject's reasoning. In one ethical dilemma the main protagonist steals a drug
to help his dying wife after a pharmacist refuses to supply it for half what he normally charged, a
sum that would still have netted a 500% profit. In this example the interviewees were asked if the
protagonist had a right to steal the drug, if he was violating the pharmacist's rights, and what type of
sentence a court should give him if he was caught. The main function of the questions was to
determine the reasoning behind the answers. The interview then continued with further moral
dilemmas so that a good sampling of a subject's moral thinking could be acquired. The results were
then classified into stages. Kohlberg also established that his scoring was reliable by working out
the level of inter-rator reliability. This was established by calculating the degree to which scorers
agreed by getting a number of scorers to independently score the answers.

Table 6.10 below shows the six stages of moral judgment that Kohlberg eventually identified
(Kohlberg, 1981)
<table>
<thead>
<tr>
<th>LEVEL</th>
<th>STAGE</th>
<th>SOCIAL ORIENTATION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-conventional</td>
<td>1</td>
<td>Obedience and punishment</td>
<td>Fear of punishment</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Individualism &amp; Exchange</td>
<td>Returning favours</td>
</tr>
<tr>
<td>Conventional</td>
<td>3</td>
<td>Good interpersonal relationships</td>
<td>Putting yourself in other's shoes</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Social Order</td>
<td>Avoiding societal breakdown</td>
</tr>
<tr>
<td>Post-conventional</td>
<td>5</td>
<td>Social contract &amp; individual rights</td>
<td>Obeying the law and upholding rights such as liberty and life</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Universal Principles</td>
<td>Guided by principles of justice, human rights and human dignity</td>
</tr>
</tbody>
</table>

Table 6.5 Kohlberg's Six Stages of Moral Judgment

Perhaps the major difference between Kohlberg's definition of moral judgment and that of Piaget was that Kohlberg defined morality in affective, cognitive and behavioural terms. In the affective domain the individual has moral ideals. These then guide moral behaviour. But for that moral behaviour to be morally mature there needs to be developed reasoning competencies. Figure 6.7 below summarises this.

![Figure 6.6 Aspects of Moral Behaviour (after Lind 2002).](image)

The relationship between these three aspects of morality led to the development by Kohlberg of criteria for the measurement of moral reasoning. He then designed the MRI where subjects took part
in an interview where they were asked to respond to moral dilemmas and then questioned on their responses. The analysis of responses was then used to determine the stage of moral reasoning of the subject.

Other researchers (Markoulis, 1989, cited in Dawson et al. (2002), Walker, 1986) have reported that there was a strong correlation between educational attainment and stages of moral reasoning. As Dawson et al (2002) report formal education is also identified as being a potential source of ‘sociomoral experience… the direct and repeated experience with moral conflict in social contexts’.

Lind (1986) took Kohlberg’s MRI further by developing the Moral Judgement Test (MJT) where subjects were presented with moral dilemmas and a number of different responses (organised into pro and con statements), each response representing a different stage of Kohlberg's six stage model. Subjects were than asked to rate their agreement with the response on a nine-point scale.

The MJT was designed so that it satisfied the main postulates, as laid down by Kohlberg, for an adequate moral reasoning measurement tool. These include:

- the ability to measure both the cognitive and affective aspects or moral behaviour
- the inclusion of a moral task
- non-fakeability (i.e. subjects should not be able to get scores higher than their moral reasoning competency)
- sensitivity to change, measure the subject's own moral principles rather than imposing external moral expectations
- equivalence of both pro and con arguments in terms of Kohlberg's six stages

The MJT uses two moral tasks to assess the subjects' moral reasoning level. The dilemma is defined by Lind (2002) as 'a situation in which a person cannot make a decision without transgressing an important moral rule or principle'. In the MJT the moral dilemmas are concerned with a mercy killing situation, the Doctor's Dilemma and a Worker's dilemma about the employees' and employers' rights and the rule of law. The moral task is contained in the arguments that the subject
is asked to score. Figure 6.8 below shows some example statements (see Appendix 6.3 for the full MJT test)

| How acceptable do you find the following in favour of the doctor? Suppose someone said he acted **rightly** |
| 20 because the doctor had to act according to his conscience. The woman's condition justified an exception to the moral obligation to preserve life. |
| 21 because the doctor was the only one who could fulfill the woman's wish; respect for her wish made him act as he did. |
| 22 because the doctor only did what the woman talked him into doing. He need not worry about unpleasant consequences |
| 23 because the woman would have died anyway and it didn't take much effort for him to give her an overdose of a painkiller. |
| 24 because the doctor didn't really break a law. Nobody could have saved the woman and he only wanted to shorten her suffering. |
| 25 because most of his fellow doctors would presumably have done the same in a similar situation |

Figure 6.7 Extract from standard MJT (Lind 2002)

In each argument the subjects then rate their response from -4 (strongly disagree) to +4 (strongly agree).

In all there are 24 arguments, 12 for each dilemma with six pro and six contra arguments. The arguments represent Kohlberg's six stages but are randomly ordered.

Subject responses are then scored using multivariate analysis of variance components to give C-index (full details of the scoring method can be found in Lind 2001). The C-index can vary from 1 to 100. C is graded as very low (1-9), low (10-19), medium (20-29), high (30-49) and very high (40-49) and extraordinary high (above 50).

The MJT is not designed for individual assessment of moral competence as a person's moral reasoning can be influenced by a number of factors such as fatigue, experiences, emotional state etc.
So, in order to guard against misinterpretation of results, subjects are first grouped and the C-index scores are then averaged for each group. This made the MJT particularly suitable for the group-based pedagogy I was adopting.

6.2.1.2 The Defining Issues Test
The Defining Issues Test (DIT) was developed by James Rest (Rest 1979). Its central purpose was to assess the transition of moral development from adolescent to adult. The DIT is also based on the work of Kohlberg and has many similarities to the MJT.

Rest, as with Lind, also built his model of the psychology of morality on Kohlberg’s six-stage model as previously described. However Rest (1994) suggested the Four Component Model as the determinate of moral behaviour.

The DIT method defines four stages (or components) in a model that might be useful in measuring learning outcomes in a course such as PISE. These are:

- recognition of the existence of a moral dilemma – the Moral sensitivity stage
- ability to make a morally justifiable decision – Moral judgement
- assessing the importance of the moral values over other values – Moral motivation
- implementing a moral action – Moral courage

<table>
<thead>
<tr>
<th>Component</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moral sensitivity</td>
<td>The awareness of how our actions affect other people and the requirement to decide between different courses of action.</td>
</tr>
<tr>
<td>Moral judgment</td>
<td>What the DIT (based on Kohlberg’s work) attempts to assess which action is more morally justifiable?</td>
</tr>
<tr>
<td>Moral motivation</td>
<td>What importance a person gives to moral values in relation to other values? Do values such as self-actualisation or protecting one’s organisation replace concern for doing what’s right?</td>
</tr>
<tr>
<td>Moral character</td>
<td>Psychological toughness and strong character is required to carry out a moral course of action. It is no good wilting under pressure.</td>
</tr>
</tbody>
</table>

Table 6.6 Four Component Model (after Rest, 1994).
The DIT is a questionnaire based multiple-choice test where subjects are given four scenarios. Each scenario is then followed by twelve statements and subjects are asked to respond using a Likert scale with 5 ratings to each of these. Table 6.9 below shows part of the DIT questionnaire.

<table>
<thead>
<tr>
<th>Should Heinz steal the drug?</th>
<th>Should Steal</th>
<th>Can't Decide</th>
<th>Should not steal</th>
</tr>
</thead>
</table>

Please rate the following statements in terms of their importance. (1=Great importance, 2=Much importance, 3=Some Importance, 4=Little importance, 5=No importance)

1. Whether a community's laws are going to be upheld.
2. Isn't it only natural for a loving husband to care so much for his wife that he'd steal?
3. Is Heinz willing to risk getting shot as a burglar or going to jail for the chance that stealing the drug might help?
4. Whether Heinz is a professional wrestler, or had considerable influence with professional wrestlers.
5. Whether Heinz is stealing for himself or doing this solely to help someone else.
6. Whether the druggist's rights to his invention have to be respected.
7. Whether the essence of living is more encompassing than the termination of dying, socially and individually.
8. What values are going to be the basis for governing how people act towards each other.
9. Whether the druggist is going to be allowed to hide behind a worthless law which only protects the rich anyhow.
10. Whether the law in the case is getting in the way of the most basic claim of any member of society.
11. Whether the druggist deserves to be robbed for being so greedy and cruel.
12. Would stealing in such a case bring about more total good for the whole society or not.

Figure 6.8 Section of DIT questionnaire (University of Minnesota, 1993).

Following the statements there is a further part of the DIT where subjects are asked to identify and rank the four statements they feel are most important.

Once the questionnaire has been completed it has to be processed by the Centre for Ethical Development at the University of Minnesota or, alternatively, a licence could be purchased.
The processing produces three different scores for evaluating moral judgement development. The D-index shows changes in the lower stages of moral reasoning, Kohlberg’s stages 2, 3 and 4. The P-index reflects changes in the higher stages 5 and 6. A further index, the N2, provides two types of information. Firstly how the subject ranks Kohlberg’s post-conventional items (similar to the P-index) and secondly developmental advancement.

6.2.2 Community of Inquiry

Garrison et al (2001) have proposed a model, the Community of Inquiry as a ‘framework for analysing critical thinking in computer conferences’. Using this model

depth and meaningful learning, ostensibly the central goal of higher education, takes place in a community of inquiry composed of instructors and learners as the key participants in the educational process.

The model proposes that by the interaction of three elements this learning takes place. These elements are Social presence, Teaching presence, and Cognitive presence. Figure 6.10 illustrates this model.

![Community of Inquiry model](image)

Figure 6. 9 Community of Inquiry model.
Teaching presence, focuses on the design and management of learning sequences, provision of subject matter expertise, and facilitating active learning. It does not refer the 'teacher presence' as the learners themselves can provide some of the foci.

Social presence is defined as the ability of learners to project themselves socially and emotionally in a community of inquiry. The authors describe this element as ‘having the function of supporting the cognitive and affective objectives of learning’ Cognitive objectives are support by social presence ‘through its ability to instigate, sustain, and support critical thinking in a community of learners’ while affective objectives are supported by:

making the group interactions appealing, engaging, and thus intrinsically rewarding, which can lead to a more successful completion of units of study by getting the learner to become more involved in the whole process.

Cognitive presence (CP) is defined as ‘the extent to which the participants in any particular configuration of a community of inquiry are able to construct meaning through sustained communication.’

Archer et al (2000) argued that provides a framework that can be used to analyse the effectiveness of online discussion in ‘supporting critical thinking in higher education’.

As was discussed previously, there are four categories in the CP element within the model of critical thinking and practical enquiry proposed by Garrison et al (2000) for the analysis of critical thinking. These are:

• triggering
• exploration
• integration
• resolution

Each category is defined using a set of descriptors. The following table shows the categories, their descriptors and indicators.
As was discussed above, some students expressed difficulty in relating the CP categorisation to the PISE assignment. I therefore developed two further versions of this table to reflect more directly on the requirements for this assignment. These are discussed in chapter 7.

216
6.3 Critical reflection on Cycle 3

This cycle focussed on tools to measure learning so that I could have confidence in my interpretation of the data that I was developing. The previous cycle had used measures of page hits and grades and I was not satisfied that these demonstrated the consequences of this pedagogy.

I investigated different tools to measure moral reasoning and identified the MJT as being more suitable for this study. However this tool produced results that again were anomalous and I could not fully trust. I therefore decided to investigate other methods of measuring learning achievement.

The Community of Inquiry and specifically the Cognitive Presence analysis provided me with an alternative method. I used this instrument to analyse student online behaviour in the discussion boards by categorising individual posts. I discovered a correlation between the grades and the CP categorisation of posts. However, there were further problems with range in the number and size of posts.

I therefore determined to constrain the number of weekly posts and the size of posts to aid scaffolding and CP categorisation. Further teaching and research cycles showed that there was a strong correlation between the rating of posts and the grades awarded.

There were still some ongoing concerns regarding the way some learners still did not seem to fully grasp how to debate and discuss ethical dilemmas online. I therefore continued to develop my guidelines for learners. I continued to follow the action research method by involving the learners in the study. Keeping them fully informed of my use of CP and MJT methods of measuring enhancement of learning in PISE.

As part of the action research approach I also continued to present papers at conferences and submit to journals so that my ongoing research outcomes would be subject to analysis by my peers and to keep the research community informed of my work.

This cycle enabled me to develop further my research, harden the questions I was investigating and
move a bit close to answering my core research question:

*Can the use of ICT enhance the learning experience of students working collaboratively in the domain of PISE?*

However there were yet more developments on the horizon which included the need to seek another VLE and further student concerns about the assessment being used. These are discussed in the next cycle.
7 Bringing it all together

7.1 Personal narrative Cycle 3

This is the final cycle of the action research I have been conducting since 2001. In this cycle I bring together the different research themes.

I initially discuss the move to an alternative VLE, Moodle, and how the constructivist paradigm is supported by this VLE. I then focus on the further development of guidelines for students to support collaborative online learning. In the third phase I discuss how I applied the Cognitive Presence (CP) framework for formative and summative assessment to help learners maximise their potential. In the fourth and final phase I discuss a new research direction, the use of data visualisation in the design and implementation of a tool to enable easier interpretation of the learning data. The following diagram illustrates the phases of Cycle 3.

![Figure 7.1 Phases in Cycle 3](image)

Following the discussions of the four phases there is a literature review section focussing on related research.
The chapter concludes with a critical reflection on the research themes under investigation in this final cycle of the research.

7.1.1 Phase 3.1 A new VLE?

7.1.1.1 Overview
To overcome the specific problems encountered using Bb over four years I began to investigate alternative VLEs. My aim was to find a tool that more easily facilitated the social constructivism pedagogy that I was using in PISE.

This was the focus of this first phase of Cycle 3.

7.1.1.2 Research Methods and data gathering
I conducted a review of the literature to determine what VLEs were currently available and undertook a comparison of features. I also compared functionality with my own requirements that had been developing during the previous cycles of research.

As is the nature of action research, I had been attending conferences to discuss my ongoing research and developing an ever larger network of colleagues who had interests in this field. Discussion with these colleagues alerted me to other VLEs and the growing number of open source systems that were being developed by research groups and individual teachers. I also researched how different VLEs were being reviewed and used.

I decided that I would again use the Salomon (1995) framework as a method of functional benchmarking as I had already used this method to evaluate Bb (see Chapter 6).

7.1.1.3 Analysis of data and critical reflection
Following an analysis of VLEs in use, I quickly identified Moodle as a potential alternative to Bb.

Moodle had been initially developed by Martin Dougiamas as part of his own PhD but had now grown far beyond this. (Further discussion of Moodle and its underlying educational philosophy is covered in the Literature review section 7.2 below).
Dougiamas (1999) had decided that for the learner the three main features of Moodle should be:

- easy navigation through course facilitated through the use of placement cues, semantic nets and hierarchies and indices
- clear simple page design thus improving download speed
- interactivity through a discussion board, journal and quizzes with the possibility of adding further functionality as required

These three features would ensure that students could learn in a socially-constructive manner.

From a teacher’s point of view the three desirable features of Moodle were:

- the ability for students to learn more about the course content through:
  - course response design
  - easy modification through a page content editor
  - the automatic structuring of the content by the system
  - student usage patterns and activities would be recorded in logs to help the teacher learn more about student learning behaviour
  - ability to monitor and engage in discussions by using the forums to help the teacher learn more about the class

These features were designed to free up time for teachers for reflection on their teaching. This also was one of my early aims as discussed in Chapters 2 and 5.

Moodle offered some immediate positives:

- it was very widely used (over 15,000 sites at the time of investigation)
- it had a large community of developers and users
- it was based on constructivist teaching philosophy
- it was Open Source (OS)

These are now briefly discussed.
The wide use of Moodle indicated that it was a well-tested and stable system. In fact, Moodle came third after Bb and WebCT in terms of number of installations. The wide community of developers and users meant that there was a lot of expertise and support for new users.

The philosophy underpinning Moodle, constructivism, was the same as I was using in my teaching. This meant that a range of tools and functionality had been built- n to facilitate this pedagogy.

The Open Source nature of Moodle meant that the code was available to anybody who was interested in developing their own amendments and updates. A number of these already existed and were also available to the broader community of users for downloading and integrating into Moodle servers. In other words, if there was any functionality lacking or needing change I could make the changes myself or integrate new components if these had already been developed by others.

On the negative side OS software tends to suffer from lack of support. However, my examination of the Moodle website showed a comprehensive and well-organised support system. If necessary, support could be purchased from one of the many Moodle partners worldwide.

Having identified these positive aspects of Moodle I then used Fjuck’s (1998) framework to further analyse functionality. As can be seen, Moodle fully provides tools to support the interactional aspects of this framework.
<table>
<thead>
<tr>
<th><strong>Interactional examples</strong></th>
<th><strong>Operational examples</strong></th>
<th><strong>Moodle tool</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Articulating meaning into information objects (text,</td>
<td>Mechanisms for articulating thoughts.</td>
<td>Forums, wikis, blogs, glossary.</td>
</tr>
<tr>
<td>hypertext, notes etc).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Producing and distributing information objects.</td>
<td>Mechanisms to down(up)load objects.</td>
<td>Attachments, forum postings.</td>
</tr>
<tr>
<td>Distributing and coordinating meanings to peers.</td>
<td>Mechanisms for attaching information objects.</td>
<td>Attachments, wikis, blogs, glossary.</td>
</tr>
<tr>
<td>Reflecting upon and elaborating on existing information</td>
<td>Mechanisms for making notes</td>
<td>Forums, rating, commenting on glossaries, responding to</td>
</tr>
<tr>
<td>objects.</td>
<td>Themed discussions.</td>
<td>wikis.</td>
</tr>
<tr>
<td>Identifying roles and tasks.</td>
<td>Mechanisms for allocation of roles.</td>
<td>Surveys – COLLES and ATTLS.</td>
</tr>
<tr>
<td>(Re) evaluating own knowledge and interpretations.</td>
<td>Self-evaluating tools.</td>
<td>Forum.</td>
</tr>
</tbody>
</table>

Table 7.2 Production/knowledge construction.
<table>
<thead>
<tr>
<th>Interactional examples</th>
<th>Operational examples</th>
<th>Moodle tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distributing and co-ordinating information objects amongst peers.</td>
<td>Mechanisms that retrieve information from social interactions. Mechanisms that retrieve lists of all actors in the social communities and other actors in the system.</td>
<td>Forum, wiki, blog, chat, instant messaging.</td>
</tr>
<tr>
<td>Commenting on information objects provided by peers.</td>
<td>Mechanisms that inform which actors are online. Synchronous and asynchronous mechanisms.</td>
<td>Forum, wiki, blog, chat.</td>
</tr>
<tr>
<td>Co-producing/co-authoring information objects.</td>
<td>Mechanisms to retrieve whole dialogues with contributions before and after that specified by actor.</td>
<td>Forum, wiki, blog, chat.</td>
</tr>
<tr>
<td>Creating a common presentation area.</td>
<td>Mechanisms for producing joint information objects.</td>
<td>Wikis, blog.</td>
</tr>
<tr>
<td>Creating learners' content annotations.</td>
<td>Mechanisms for categorising dialogue items according to keywords.</td>
<td>Rating.</td>
</tr>
</tbody>
</table>

Table 7.3 Information sharing/joint construction.

<table>
<thead>
<tr>
<th>Interactional examples</th>
<th>Operational examples</th>
<th>Moodle tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organising the group/project.</td>
<td>Mechanisms for producing joint information objects.</td>
<td>Forum, wiki, blog, chat.</td>
</tr>
<tr>
<td>Articulating responsibility and commitments.</td>
<td>Minutes of meetings and decisions taken.</td>
<td>Forum, wiki, blog, chat.</td>
</tr>
<tr>
<td>Articulating time for meetings etc.</td>
<td>Mechanism for using joint calendar facility.</td>
<td>Forum, wiki, blog, chat.</td>
</tr>
<tr>
<td>Making common plans using responsibility/milestone charts.</td>
<td>Project management tools.</td>
<td>Calendar.</td>
</tr>
<tr>
<td>Maintain awareness of how particular activity fits into individual's knowledge and progress.</td>
<td>Mechanism for retrieving an overview of individual's status.</td>
<td>Rating.</td>
</tr>
<tr>
<td>Maintaining awareness of learner's interaction with collaborative environment.</td>
<td>Mechanism to count number of interactions.</td>
<td>Forum, alerting, rating, statistics showing type of interaction.</td>
</tr>
</tbody>
</table>

Table 7.4 Division of labour.

When compared with Bb some operational examples indicated that Moodle would have far superior functionality. Appendix7_1 describes the functionality of Moodle in detail.
I also investigated the hardware requirements for Moodle. Essentially it is a very lightweight computer system and requires only a small amount of computing power compared to other VLEs such as WebCT and Bb. The proposed update path had indicated that soon I would have to find more powerful servers for Bb. The hardware requirements for Moodle meant that it could be installed on our existing servers.

Once again the organisational constraints that might have affected the choice of VLE were removed. I could adopt Moodle at no financial cost to my department.

7.1.2 Phase 3.2 Developing guidelines

7.1.2.1 Overview
During the next four academic years I continued my research. In each year I had one opportunity to teach and assess PISE. The research methods were the same as discussed in Chapter 5, the multi-institutional collaboration. However there were to be some significant differences, and these enabled me to explore and develop a number of research themes:

- constraints on multi-institutional collaboration
- developing guidelines to enhance online discussion and debate
- an improved structure to encourage group formation and sustainability
- more formal methodology for assessing the assignment

I progressed these themes in response to student feedback, following discussion with collaborating partners, and by taking into account the feedback I received at conferences where I discussed my research.

A major change for this cycle was in the collaborating institutions. Both existing partners decided they could no longer continue with their collaboration. Pat Jeffries at de Montfort University was moving on. Prof Grodzinsky was unwilling to have her students spend time learning how to use another VLE as Sacred Heart University had invested much time and money in Bb themselves. I therefore had to find more partners.
There was a positive aspect to this as it would give me the opportunity to see if my pedagogical model could be used with different groups of students from different institutions. It would enable me to generalise my own research to a larger community and would also help me to validate my interpretation of the data that I was gathering.

7.1.2.2 Research methods and data gathering
I continued to gather feedback from students using surveys, questionnaires and focus groups. This data was used to inform my ongoing research and to confirm (or contradict) research themes and to seek new research insights.

I once again posted my request for collaboration on various discussion lists. I also included reference to my search for new partners in papers presented to conferences. Eva Turner from the University of East London (UEL) and Gill Rawlings from Edgehill College, Lancaster University (EHC) both contacted me at conferences where I was presenting, and following discussions agreed to collaborate with me in the next cycles of teaching and research.

I continued to gather data on student online behaviour by analysing the types of discussion. I was trying to improve the threaded discussions and one way was to consider the length of these ‘conversations’.

I kept my journal up to date and made notes during each cycle of teaching and research of further ideas I had to improve the effectiveness of my pedagogy. I continued to record significant events and discussions with students and colleagues. I also continued to read the literature in related areas to my research. I also joined a number of discussion lists on e-learning, CSCL, CSCW, computers and philosophy, action research and educational philosophy, because my research area spanned a number of different disciplines. Being aware of developments in many of these was time consuming but also enlightening.
7.1.2.3 Analysis of data and critical reflection

In this section I discuss a number of issues that developed in the ongoing research and teaching. These issues include:

• recommendations for multi-institutional collaboration
• guidelines for students to enhance their online discussion ability
• a better structure to encourage group formation and sustainability
• more formal methodology for assessing the online discussion

These are now discussed.

7.1.2.3.1 Recommendations for multi-institutional collaboration

There had been a number of management issues in my previous collaborations, as previously discussed. These led me to identify constraints which I believed should be addressed before embarking on a new round of multi-institutional teaching and learning collaboration. Furthermore, some potential collaborators had been unable to become involved because of specific issues. I analysed this information and produce a set of potential recommendations for successful collaboration. These included:

• student cohorts should have similar profile e.g. undergraduate, studying CS degree
• module content should cover the same areas, e.g. computer ethics, ethical analysis
• potential partners must be willing to use the Moodle server at UL, i.e. they must have Internet access
• partners must have similar academic calendar with at least six weeks overlap in teaching semester
• the requirement that all collaborating learners had a comparable level of English

I incorporated this information into a single document I sent to all potential collaborators so that they had enough detail at the outset to decide if they would able to participate in the multi-institutional collaboration. This is reproduced in Appendix 7_2.
Guidelines for students to enhance their online discussion ability

The second strand of this research phase focused on the methods I developed to enhance student ability in online discussion. My ongoing analysis of threaded discussions had identified some issues, and student feedback had alerted me to others.

The following is a list of reasons I formulated in response to a question often raised by learners:

*Why use Moodle?*

My responses included the following, and were based on my own research findings and those of the literature. As was discussed in Chapter 2, asynchronous communications proven to help develop knowledge because:

- this mode of learning allows time for reflection
- it rewards the ‘process’ and not just the ‘product’
- it produces an audit trail of individual effort
- the audit trail enables individual contributions to be assessed
- the audit trail also contributes to reducing plagiarism
- multi-institutional collaboration supported by ICT facilitates geographically dispersed groups to work together

Some students also had difficulty in grasping exactly what was required in the assessment. Using computer-mediated discussions in an academic context was a new departure for most learners. I therefore felt that further guidelines needed to be developed. The following extract is from my journal, and concerns the guidelines I needed to develop and give to students in PISE.

*Problems raised over mechanics of using forums for discussions. Need more formal input on how this is to be done. Continuing issues over how to get students to produce better posts and more discussion threads. Things that might help overcome these:*

- *Do more on guidelines on postings*
- *Explain marking scheme in more detail*
• Get students to:
  • discuss and select a framework to use for ethical analysis
  • apply framework to case study
  • identify ethical considerations and ethical theories
  • apply these
  • consider counter-arguments
  • evaluate findings and conclusions

I had already determined that I would use the CP framework (Chapter 6.1.4) to assess student online discussion. However, that framework was of a general nature and I needed to amend and update it to reflect the type of issues that were specific to PISE.

As discussed in Chapter 6, I also started developing a set of posting guidelines based on my reading of the literature and my analysis of the common errors students made. The analysis had identified a number of issues:

• need for a clearly defined period in which the online discussion would take place
• need to ensure regular posting (some students would often not post until towards the end of the assessment period. This meant that they were not contributing to any ongoing discussion and in some cases were limiting the potential of others in their group to develop arguments)
• raising the quality of posts e.g. to avoid giving personal and unfocussed viewpoints, digressing or submitting overly long posts covering a range of topics.
• need for updating and publication of CP framework so learners could assess the quality of their own posts

This led to the development of guidelines which were refined over four teaching and research cycles. The following is an extract from the final version of the guidelines.
Guidelines for successful posting

1. You should focus on the topics posted. But do bring in related thoughts and material, other readings, or questions that occur to you from the ongoing discussion.

2. You are expected to post at least three substantive messages or four or more smaller posts (about 450 words per person per week for three/four weeks) for assessment. The aim is to create an online ‘conversation’ and encourage debate and discussion. Your postings should reflect an understanding of the ethical theories as applied to the case studies.

2. Each post should contain a single theme or idea. If you want to respond to more than one argument then use a separate post for each argument/response. You will get just one rating as per the Analysis of Cognitive Presence to determine the quality of your post as this may help you to develop arguments that will get more marks or higher grades. (You may also post other messages which are for general communication purposes. These will not be assessed. So make sure that the assessed posts are in a separate thread and clearly identifiable.)

3. Your postings should advance the group's negotiation of ideas and meanings about the case study, i.e. your contributions should go beyond a ‘ditto’ or ‘I agree’ type of response. Some ways you can further the discussion include:

- expressing opinions or observations - these should be offered in depth and supported by more than personal opinion, e.g. use references
- making a connection between the current discussion and previous discussions, use concepts from the readings, e.g. stating the arguments for and against a particular ethical theory
- commenting on or asking for clarification of another student's statement can help to develop the discussion
- summarising other group members' responses, or posing a substantive question can also help the group's understanding and develop the discussion
- build on other responses to create threads but be careful not to introduce many different arguments, unless you edit the subject line to the new topic

Figure 7.2 Extract from guidelines for posting on Moodle

7.1.2.3.3 Building virtual learning groups

An aspect of this study that has needed careful consideration is the issue of building virtual learning groups. Much research has already been carried out in the area of group dynamics, mainly in face-to-face (f2f) groups. However, the problems that can occur in establishing trust and sustaining f2f groups are exacerbated in virtual groups where members may never meet physically. I had already identified some issues associated with geographically dispersed groups (see Chapter 2). Further
research (discussed below in section 7.1.2) suggested additional ways to help this process involving
two distinct phases:

- forming team
- allocating roles and tasks

To address these I developed a framework that I believed would contribute to the establishment and maintenance of virtual learning groups. This is outlined below.

- Get students to behave 'socially'. For example, students undertake a social activity such as introducing themselves, telling others about their families, friends, interests, giving an example of what social event they enjoyed over the previous weekend or other storytelling exercises.
- Undertake a team-building exercise. This is achieved by having group members discuss and debate a contentious issue that concerns them personally. For example, should universities monitor student email activity and is downloading pirate MP3 files OK?
- Allocate marks to these tasks to encourage engagement by students.
- Have group members work together to select a case study by using personal experience to demonstrate some background knowledge. For example, students may have technical knowledge that would contribute to the overall group expertise.
- Encourage group members to allocate roles and tasks and create a project plan for an assignment.
- Have students work in pairs to minimise disruption should any student not contribute.
- Create well-defined time periods for activities. This is illustrated in Figure 7.3 below.
- Use an assessment method that provides students with feedback on the quality of their posts so that quantity does not become the yardstick used by learners to grade their own performance.

As was mentioned previously, I also decided to constrain the time period allocated to the online discussion. My journal from this time has the following entry:

*Process to run for set period, e.g. 3 weeks?*
Factoring this into my timetable led to the following format for the collaboration.

<table>
<thead>
<tr>
<th>Task number</th>
<th>Task description</th>
<th>Deadline (you may complete earlier):</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Register with Moodle</td>
<td>Week 1</td>
</tr>
<tr>
<td></td>
<td>Add/ update personal profile</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Explore moodle</td>
<td>Week 2</td>
</tr>
<tr>
<td></td>
<td>• start a discussion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• reply to a discussion</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Form into groups of 3</td>
<td>Week 2</td>
</tr>
<tr>
<td></td>
<td>Note: this is on a voluntary basis, but students will</td>
<td></td>
</tr>
<tr>
<td></td>
<td>be allocated to a group if there is no input</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Groups to socialise on-line</td>
<td>Week 3</td>
</tr>
<tr>
<td></td>
<td>1. build up a group identity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. build up group trust</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Select case study</td>
<td>Week 4</td>
</tr>
<tr>
<td></td>
<td>Inform tutor of selection</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Online assignment period</td>
<td>Week 5 - 8</td>
</tr>
<tr>
<td>7</td>
<td>Hand in completed assignment</td>
<td>Week 9</td>
</tr>
</tbody>
</table>

In task 4 above:
Team building exercise will lead to formative assessment (contributions worth up to 10% of marks) of postings on moodle.

In task 6 above Selection of Case study
Use a variety of ethical theories. E.g. each pair of students is to choose one ethical theory and defend it against the other two theories used in the group.

Assessment will involve the grading of postings as described in the posting guidelines and the Report marking document (links from Moodle). Some marks will also be given for pre-assignment contributions (serious ones, not just chit chat).

Total word count approx. 6,000 words for the report

Figure 7.3 Collaboration timetable.

In Task 6 above there is reference to students working in pairs. I had decided on this approach to minimise disruption to the group if one member did not contribute. Each pair selected one ethical theory and debated the dilemma from that perspective. By adopting this approach, student pairs...
could work together and use their ethical perspective to defend their argument and also to critique those of others in the group. If any individual student failed to contribute then other of the pair could continue the debate and the overall group discussion would not be compromised. If both students in a pair withdrew then the remaining members could also continue their discussion, albeit with one perspective removed.

7.1.2.3.4 A more formal methodology for assessing the online discussion

The next task was to develop a more formal method for assessing the online discussions. I therefore started to adapt the CP framework specifically for the domain of PISE and computer ethics analysis. I focussed on an area of ethical analysis, i.e. the difference between two types of claim in ethical argument as this often seemed to cause problems for learners and had been a focus of my introduction to the topic of ethical discussion in lectures. The two types of claim are:

*Descriptive* which describe an ethical problem e.g. *82% of users have pirated software on their computers.* This type of claim does not tell us anything about whether or not this is morally correct behaviour. However, this style of argument is sometimes used to justify a behaviour as being moral or ethical.

The second type of ethical claim is *normative.* This type of claim asserts what *ought* to be or what *should* be. So telling lies is wrong, stealing is wrong. It is a higher level of claim and one that needs justifying with supporting arguments.

My analysis of student posts had identified that descriptive claims were frequently used to support an ethical argument. I expected students to argue at a higher level, from an ethical perspective as it would be indicative of higher-order critical thinking (c.f. Piaget, Kohlberg, Lind). Therefore my first development of the CP framework was to indicate how the different levels of post related to the concepts in ethical discussion. This is shown in Figure 7.4 below, my changes shown in *blue italics.*
<table>
<thead>
<tr>
<th>Type</th>
<th>Descriptor</th>
<th>Indicator</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triggering</td>
<td>Evocative/</td>
<td>Recognising the</td>
<td>Presenting background information that culminates in a question.</td>
</tr>
<tr>
<td></td>
<td>descriptive</td>
<td>problem</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sense of</td>
<td>Asking questions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>puzzlement</td>
<td>Message that takes discussion in a new direction</td>
</tr>
<tr>
<td>Exploration</td>
<td>Inquisitive/</td>
<td>Divergence within the</td>
<td>Unsubstantiated contradictions</td>
</tr>
<tr>
<td></td>
<td>descriptive</td>
<td>online community</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Divergence within a message</td>
<td>Many different ideas/themes in one message</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Information exchange</td>
<td>Personal narratives/descriptions/facts (not used as evidence to support a conclusion)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suggestions for consideration</td>
<td>e.g. ‘Does that seem about right?’, ‘Am I way off the mark?’</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brainstorming</td>
<td>Adds to established points but does not systematically defend/justify/develop addition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leaps to conclusions</td>
<td>Offers unsupported opinions</td>
</tr>
<tr>
<td>Integration</td>
<td>Tentative/</td>
<td>Convergence -among group members</td>
<td>Reference to previous message followed by substantiated agreement, e.g. ‘I agree because…’</td>
</tr>
<tr>
<td></td>
<td>Descriptive but more likely normative</td>
<td>Convergence -within a single message</td>
<td>Justified, developed, defensible, yet tentative hypotheses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Connecting ideas, synthesis</td>
<td>Integrating information from various sources - textbooks, articles, personal experience</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Creating solutions</td>
<td>Explicit characterization of a message as a solution by participant</td>
</tr>
<tr>
<td>Resolution</td>
<td>Committed/</td>
<td>Vicarious application to real world</td>
<td></td>
</tr>
<tr>
<td></td>
<td>normative</td>
<td>Testing solutions</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Defending solutions</td>
<td></td>
</tr>
</tbody>
</table>

Figure 7.4 First adaptation of the CP framework for categorisation of posts.

Following on from the first teaching and research cycle I gathered feedback from students using the usual methods of questionnaires and focus group meetings. The main findings were that although some found this new framework useful it seemed to have made little difference to the majority who
still felt it was too abstract. A common request was for some example posts or statements to be added.

I once again spent a good deal of the summer months re-reading posts that had been submitted in the threaded discussions. I identified response types that were common to posts in each category. I also adapted some of the processes from ethical argument and incorporated these. I then used this information to update the Descriptor, Indicator and Process fields in the framework. This is shown in Figure 7.5 below (again my amendments are shown in **blue italics**).

<table>
<thead>
<tr>
<th>Type</th>
<th>Descriptor</th>
<th>Indicator</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Triggering</strong></td>
<td>Evocative/ descriptive</td>
<td>Recognising the problem</td>
<td>Presenting background information that culminates in a question. <strong>Superficially identifies or attempts to identify moral dilemma</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sense of puzzlement</td>
<td>Asking questions Message that takes discussion in a new direction</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Confusion</strong></td>
<td>Confuses ethical and legal/social consequences</td>
</tr>
<tr>
<td><strong>Exploration</strong></td>
<td>Inquisitive/ descriptive</td>
<td>Divergence within the online community</td>
<td>Unsubstantiated contradictions or contradictions not based on ethical analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Divergence within a message</td>
<td>Many different ideas/themes in one message</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Information exchange</td>
<td>Personal narratives/descriptions/facts (not used as evidence to support a conclusion)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suggestions for consideration</td>
<td>e.g. ‘Does that seem about right?’, ‘Am I way off the mark?’</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brainstorming</td>
<td>Adds to established points but does not systematically defend/justify/develop addition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leaps to conclusions</td>
<td>Offers unsupported opinions</td>
</tr>
<tr>
<td><strong>Incorrect rendition of ethical theory</strong></td>
<td></td>
<td></td>
<td><strong>Wrongly interprets ethical theory, partially applies ethical theory, confuses different theories, applies inappropriate theory to analysis</strong></td>
</tr>
<tr>
<td><strong>Contains little or no ethical analysis</strong></td>
<td></td>
<td></td>
<td>Fails to apply any ethical theory, off topic</td>
</tr>
<tr>
<td><strong>Repetition</strong></td>
<td></td>
<td></td>
<td>Essentially repeats a previous argument</td>
</tr>
<tr>
<td><strong>Integration</strong></td>
<td>Tentative descriptive but more likely normative</td>
<td>Convergence - among group members</td>
<td>Reference to previous message followed by substantiated agreement, e.g. ‘I agree because…’</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------------------------------------</td>
<td>-------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Agree to disagree</strong></td>
<td>Show how different ethical theories can assert different actions as being morally right</td>
<td>Convergence – within a single message</td>
<td>Justified, developed, defensible, yet tentative hypotheses</td>
</tr>
<tr>
<td><strong>Connecting ideas, synthesis</strong></td>
<td>Integrating information from various sources - textbooks, articles, personal experience</td>
<td><strong>Creating solutions</strong></td>
<td>Explicit characterization of a message as a solution by participant but weakness in ethical analysis</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td>Committed/normative</td>
<td>Vicarious application to real world</td>
<td>Argues counter point ‘What ought to be’ phase</td>
</tr>
<tr>
<td><strong>Testing solutions</strong></td>
<td>Identifies values, goods and bads, rights and wrongs robust ethical analysis</td>
<td><strong>Defending solutions</strong></td>
<td>Interpret facts in light of principles and theories… Uses supersession</td>
</tr>
</tbody>
</table>

Figure 7.5 Second enhancement of CP framework.

Feedback following the next teaching/action research cycle was much more positive and indicated that students were more aware of what constituted the different posting types. I felt that I was now moving closer to devising a way to enhance student learning and critical thinking by the development of better guidelines.

As a further method of determining any improvement in learning I also undertook an analysis of the threads to see if thread length has changed. The results are shown in Figure 7.6 below.
As can be seen there is a marked difference between 2005 thread lengths and those of later years (I stopped collecting data on thread lengths after 2007 because of the new limitation of a maximum of 9 posts per student.) This coincides with the introduction of updated guidelines (Figure 7.3 above, and the enhanced versions of the CP framework. By triangulating the qualitative and quantitative data, I was receiving confirmation that my changes were improving the contribution of VLEs to the enhancement of learning in PISE.

However, as I had now come to expect, there were also some negative comments indicating another area that needed investigation. Below are examples typical of the feedback I recorded in my journal.

‘Posting guidelines and Assessing posts docs OK but I have problems knowing how I am doing.’

‘Sometimes it is difficult to know who well you are doing.’

‘It would help if you could tell us how we are progressing’

‘Can you let us know if we are getting good marks for our posts.’

‘It would help to know how I am doing compared to others’

‘How many marks is this worth?’

‘What is the percentage of this for the entire assignment’
‘How many of each type do I need to post’

‘How can I get marks for my work when others are not doing as much’

Learners, while appreciating the additional information this amended framework now provided, were still not sure how they were progressing and what they were achieving. The comments I was getting indicated that ongoing, or formative feedback, was also going to be required. Furthermore, student comments also indicated that knowledge of how marks were being allocated, even for individual posts, was an important consideration. This led me to the next phase of research in the study.

7.1.3 Phase 3.3 Assessment feedback to enhance learning

7.1.3.1 Overview
In this phase of Cycle 3 I discuss the development of assessment feedback in PISE. I had already wanted to develop a better scheme for assessing individual performance while still continuing with the group-based approach. I also needed to satisfy external examiners and other quality assurance stakeholders that the group-based approach did not distort the grades allocated to individual students. And I needed to be able to justify the individual grade and mark allocated in the event of a query.

Furthermore, as discussed previously, some of my student feedback had indicated that while the majority of learners thoroughly enjoyed the discussion and debates engendered by the case study dilemmas, learners were not sure how they were progressing in the module until they had been awarded their grade for this assignment. I therefore began to consider the possibility of using results of the CP categorisation process for individual grades for formative and summative assessment.

7.1.3.2 Research methods and data gathering
I re-read my journal and the student feedback to ascertain outstanding issues. An entry from my journal shows one such:
Provide information on categories of postings (Triggering, exploration etc) for a tutorial, get students to produce one of each type in tutorial and post on forum

Ensure students are aware of learning outcomes

Marking posts?

I continued my reading of the literature and my attendance at conferences to keep myself up-to-date on research developments.

I continued my analysis of Moodle functionality exploring other tools. I identified one such tool which is part of the Moodle Grade function. This is the Scales tool and is described in Appendix 7_3. This enables teachers to rate each post and also allows students to see their own grade.

7.1.3.3 Analysis of data and critical reflection

The use of the Moodle Scale tool and Grade functions allowed me to use the CP categorisation to provide formative feedback for learners. I had previously, along with other researchers, used the CP framework for research (Griffin, 2005). However, as has been stated previously, part of the power of action research is as a change creating process. By using this data for formative feedback I was using my research on assessing student learning to influence that very learning.

The way I was now using the CP framework enabled criterion-based feedback (see section 7.3.2 below) to be used for formative assessment. I had previously (see section 7.1.2.3.3 above) developed a set of parameters on the number and size of posts and the rate at which students posted to the discussion thread. This meant that I was assessing broadly similar amounts of student work for each learner. I was, therefore, able to use norm-referencing to see how students were performing in relation to each other. Figure 7.7 below shows a typical output.
I could also use this data as feedback on my own teaching input. I was able to identify at an early stage students who were under-performing and intervene as required. This helped me decide if I needed to re-visit concepts covered in lectures. If students were consistently posting triggering or exploration posts then one reason might be that they were unable to post higher-level posts due to difficulties problem solving at the higher levels.

Learners were also able to see how they were performing. Figure 7.8 below shows the information available to each learner in Moodle.

This view enabled the user to see how many, and at what level, all their posts had been assessed. In the example above the learner has had three posts rated. Because of the way the Gradebook is set up in Moodle an average grade is also shown. The next line shows that there were no triggering posts, one exploration post, two integration posts, and no resolution posts.
The use of the CP framework to categorise posts enabled me to provide the formative feedback requested by students, but there was also the question of summative assessment and individual grades.

As was discussed in Chapter 2, individual reward can be a motivating factor for students working in group-based assignments. This was also the case in PISE, and feedback and questions from my students had raised this issue. Some students liked to know how many marks they could achieve for different assignment tasks. Furthermore, different stakeholders, e.g. external examiners, students, exam boards, required me to be able to justify the grades awarded to individual learners.

I had already been developing a grading system whereby part of the marks for the assignment would be for the group-based work, and part for the individual contribution, using the audit trail of posts to determine how much each learner had contributed. In earlier phases of the research I used a crude measure, which compared individual student posts to the highest number of posts for the cohort, and allocated marks according to the percentage of the total each student achieved. However this did not reflect the quality of post, just the quantity.

I had begun to formalise the grading of posts using the CP framework. I therefore started to investigate the potential for assigning marks to each categorization.

My initial aim was to find a split of marks for the assessment that rewarded individual contribution but also sufficiently rewarded groupwork. Research indicates that too much reward for individual contribution works against the collaborative aspect of group-based projects.

Adopting the iterative approach of action research, I altered the relative weighting of these two components. Over four teaching cycles I analysed student grades and used student feedback to assess the consequences of allocating different proportions of the assignment marks for individual and group contribution.
I started with an 85%/15% split (groupwork/individual contribution) but student feedback indicated that this proportion did not strongly affect behaviour. It would still be possible for a ‘free-rider’ to benefit from a good group grade. Over the succeeding teaching/research cycles I gradually adjusted this split as follows (groupwork/individual contribution):

- Year 2 25/75
- Year 3 35/65
- Year 4 45/55

At the same time as I was developing this grade allocation I had also been developing guidelines for the number of posts (see section 7.1.2.3.2 above), and I had finally arrived at the requirement for each team member to post nine times to the discussion. Allocating 45 marks for individual contributions split over 9 posts meant 5 marks for each post was the maximum that a student could achieve if they produced 100% of their posts in the Resolution category.

I then assigned marks to the other categories as shown in Table 7.5 below

<table>
<thead>
<tr>
<th>Type</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triggering</td>
<td>1.25</td>
</tr>
<tr>
<td>Exploration</td>
<td>2.5</td>
</tr>
<tr>
<td>Integration</td>
<td>3.25</td>
</tr>
<tr>
<td>Resolution</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Table 7.5 Allocation of marks for CP categorised posts.

It was now possible for students to ascertain the marks they were awarded as part of the criterion-based feedback. I could also use this for assigning individual marks to the members of each group. In other works, I had a transparent method of allocating marks to all members of a group that could be verified by any stakeholder associated with PISE.

However, one problem with this feedback was that it only showed criterion-based feedback. Some student comments also indicated that reference-based feedback would be helpful (mainly competitive students who liked to compare their progress with others in their class).

I therefore decided that it would be useful to make this additional data available to students. I determined to develop a system whereby students could see how they were doing on a number of
different criteria as this was not available in Moodle. I decided that I would allow them to see their referenced-based performance by also allowing them to see the class average, the highest and the lowest class grade. These latter would be displayed anonymously and this was incorporated into the next phase of the research.

7.1.4 Phase 3.4 Using Data visualisation for formative feedback

7.1.4.1 Overview
Students indicated that they found the Moodle feedback function difficult to follow. As a lecturer I also needed to be able to access data on student learning behaviour to enable me to intervene when educationally desirable. Moodle provided a number of different systems to extract data using the Moodle report function (see Appendix 7.1). However the sheer volume of data that a large cohort creates made it difficult for me to spot trends or learners who may require assistance.

Data visualisation (DV) is a technique that uses graphical representation to display complex data sets and abstract important information. I decided to develop a tool that applied DV to the student learning data, and to trial this along with the existing data reporting methods as part of this phase of my research.

7.1.4.2 Research methods and data gathering
My focus in this phase was to examine the benefits of using data visualisation techniques in the development of a graphical interface to a formative feedback mechanism. To do this I produced a system specification for the proposed system which was to be called DVReport. The coding was undertaken by a student as part of the undergraduate final year project.

DVReport was built in php, the language used for Moodle, and was added as a new block to the Moodle library of functions. This meant I could incorporate DVReport as a function in my online courses.
Students used DVReport for reference- and criterion-based formative feedback. Lecturers used the new tool to view up-to-date qualitative and quantitative data on student online behaviour in Moodle. I then obtained feedback from the students on this new tool using interviews and focus groups.

7.1.4.3  Analysis of data and critical reflection
I established the requirements specification for DVReport with two foci, one for lecturers and one for students.

For the lecturers the focus was to evaluate students' progress by providing easy access to data on student interaction with Moodle. This was to be achieved by providing visualisation to:

- display all students interactions with the forums on Moodle showing the number of posts, views and discussions started, the quantitative data
- display the formative assessment for each student gathered from the CP categorisation of posts, the qualitative data
- show the lecturer how the progress of a student compared with that of other average, worst and best students in the class, both quantitative and qualitative data

The focus for the student was to improve achievement by providing formative feedback as a means to evaluate their progress. There were two specific aims:

- provide students with a visualisation enabling them to compare their own progress with that of other students in the class (average, worst, best) on the number of posts, views and discussions started, the quantitative data
- provide feedback by displaying for students their progress compared with that of other students in the class (average, worst, best) gathered from the CP categorisation of posts, the qualitative data
- because people understand graphical data differently offer different types of visualisation so the student can choose the one that helps them most

7.1.4.3.1  Quantitative feedback
In the early stages of the module students used Moodle for a number of reasons.
**Social stage** - where students familiarised themselves with the system and participated in discussions that were not assessed.

**Group Formation stage** - where students formed groups and managed different organisational issues such as selecting a case study for the assessment.

Neither of these were assessable activities, but I needed to know that all students were contributing.

As was discussed above, Moodle records a large amount of data on user interactions with the system including how often resources are accessed, whether the user views the resource or adds material. The system also records the time and date of each interaction.

![Figure 7.9 Usage logs on Moodle.](image)

As can be seen the data is displayed as a table in which the different types of information can be difficult to extract, especially when there are a large number of interactions. The screenshot above is the first of 463 pages of data to be shown! (I could select individual students, specific activities or certain days, but each of these would produce a separate set of data and it was not easy to compare.)

DVReport produced the following output of quantitative data for the lecturer view.
As can be seen, it is easy to identify individual student interaction with Moodle. I could also easily compare the interactions (viewing posts, starting new discussions or adding to existing threads) each student had with Moodle with a single view.

In Figure 7.10 above the second student’s data alone would have taken many pages of the Moodle log to display as he had at this stage views over 2400 interactions. (The bracketed figure at the end of the bars shows any change in relative position between one view of the data and a later view. A plus figure indicates a student had moved up the list relative to others and a negative figure indicates a move down. The numeric indicates the number of positions moved. Thus I could also see how students were doing relative to others in the class.)

A student would see the following view.
The first line in the output shows the student’s own behaviour. Students could also see how they were performing relative to the highest, lowest and average in the class without the identities of those students being revealed.

7.1.4.3.2 Qualitative feedback
The second kind of feedback I wanted to display was qualitative. This was the aggregation of ratings following the CP categorisation process as described above (section 7.1.3.2). This was the Assessment stage where every group member posted their contributions to the case studies. As each post was individually rated on a weekly basis this enabled me to provide formative feedback.

Moodle displayed this data in a spreadsheet format which I found it difficult to interpret due to the volume of data generated as the module progressed. Students were also unable to see how their assessment compared to others. With DVReport this data was displayed graphically and it was easier to abstract meaning. Figure 7.12 below shows the lecturer view.
The graphs were easily digested and the relative position of each student could also be seen at a glance. It was also possible to still see the data in numerical form as this was displayed after the graphical output as shown in figure 7.13 below.

Figure 7.12 Lecturer view of qualitative data output using DVReport.

Figure 7.13 Graphical and numerical output from DVReport.
With these different outputs it was possible for me to be fully aware, easily and efficiently, of student interaction with Moodle and their progress at each stage in the ethical dilemma assignment. I could intervene if a student was not achieving as much as I expected.

Students had a different view to the lecturer of the qualitative data. As with the quantitative data, the student can only identify their own details by name, but are also shown the highest, average and lowest score for the entire class. This enabled anonymity to be maintained while at the same time providing students with a reference point to compare their own performance with the others in the class. This is shown in Figure 7.14 below.

![Figure 7.14 Student view of qualitative output from DVReport for assessed posts.](image)

From the student perspective, with DVReport the learner was able to judge their own performance using both norm- or criterion-referencing.

### 7.1.4.3.3 Feedback from students
I interviewed students on their use of DVReport. They were overwhelmingly positive about this tool and how it had helped them assess their progress. It was much more used than the original Moodle facility that offered similar information but in a non-graphical mode.

I am continuing to assess and develop DVReport in the light of ongoing use and student feedback.
7.2 Justification from the literature

In this section I discuss the research relating to this cycle of the study. I have divided this into four sections to reflect the four phases in this cycle.

7.2.1 Selecting a new VLE

There is substantial literature that asserts that asynchronous discussion board communication can be employed to facilitate co-construction of knowledge, and the development of intersubjectivity and communities of practice (Bober and Dennen, 2001, Bonk and Kling, 1998, Lock, 2002, Naidu, 1997, Riel and Fulton, 2001). In effect, these tools support the constructivist educational philosophy.

In Chapter 2 the constructivist paradigm was discussed at length. Moodle is based on one particular constructivist theme, constructionism.

Constructionism is mostly associated with the work of Seymour Papert (1996), the originator of the LOGO programming language. Although it is based on the constructivist paradigm it asserts that learning is particularly effective when constructing some external artefact for others to experience. Papert (1996) defines it as follows:

\[\text{Constructionism shares constructivism's connotation of learning as 'building knowledge structures' irrespective of the circumstances of the learning. It then adds that this happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity, whether it's a sandcastle on the beach or a theory of the universe...}\]

For example, you might read this page several times and still forget it by tomorrow. However, if you were to try and explain these ideas to someone else in your own words, or produce a slideshow that explained these concepts, you would have a better understanding that is more integrated into your own ideas.

Dougiamous (1998) has proposed a further variation of constructionism which he calls social-constructionism. He re-stated some of the principles of social-constructivism in his definition of social-constructionism as his core design assumptions for Moodle.
Dougiamous also argues that students come to class with an established world view formed by years of prior experience and learning, and even as it evolves, a student's world view filters all experiences and affects their interpretation of observations. For students to change their world view requires effort and this can be facilitated in a number of ways. For example:

- students learn from each other as well as the teacher
- students learn better by doing
- allowing and creating opportunities for all learners to have a voice promotes the construction of new ideas

Although Bb operationalised some of these constructivist themes it was the design of Moodle that made them more easily useable by students and teachers. A full description of the functionality in Moodle is discussed in Appendix 7.1.

7.2.2 Developing guidelines

The use of online learning environments to facilitate group-based learning has not always met with success. Researchers/teachers have therefore attempted to address this issue by adding structure or constraints to interactions, such as assigning students roles, using problem-based learning and grading individual contributions (Cho and Jonassen, 2002; Hara, Bonk, and Angeli, 2000; Hung and Chen, 2003; Wu, 2003).

Dillenbourg (1999) has pointed out that in many instances collaborative learning describes a ‘situation in which particular forms of interaction among people are expected to occur’ but he warns that this expectation is often not realised. He suggests that to increase the probability of collaborative learning taking place there are a number of specific factors that need to be put in place.

*Setting up initial conditions.* For example, what is the optimal group size, what criteria should be selected for balanced membership, should members be of the same developmental age and level of
knowledge? The tools used also need to be carefully considered for functionality. Tasks for collaborative learning activities also need to be carefully considered.

**Over-specifying the collaboration contract.** This is achieved by establishing roles among learners such as in conflict interactions, having learners adopt a specific role in argumentation, expressing views that are not their own, giving different viewpoints to group members, selecting problems that can have multiple solutions. The tools used should also force the learners to integrate their respective knowledge.

**Scaffolding productive interactions.** This can be achieved by incorporating interaction rules into the context, e.g. ‘Everybody must give his or her opinion’. The interaction rules may need reinforcing and this can be built into the VLE or can be facilitated by the teacher.

**Monitoring and regulating interactions.** The role of the teacher becomes that of facilitator, with the function not of providing the right answer, but rather to ‘perform minimal pedagogical intervention’ by providing some occasional small hints.

The development of guidelines, which is discussed above (section 7.1.2.3.2), was based on these factors.

Kapur et al (2007) have highlighted further problems in relation to using discussion boards in learning. They point out that there is a particular difference in online communication and face-to-face discussion. They believe this is due, in part, to the way people read and post on bulletin boards. Learners tend to read from the bottom up, checking most recent threads first. The chances are small that any one student reads enough of a thread to identify and follow idea development which, they argue, is like walking in on the middle of an ongoing conversation. I made sure students did more than just read, they had to respond to others, part of the script/guidelines for posting I developed.

Jonassen and Kwon (2001) found that online groups had higher levels of satisfaction when they worked on ill-structured problems, and that they rated the quality of group problem-solving
processes more highly than working in face-to-face groups. Other research (Luppicini 2007) has also found that online groups, while producing fewer messages, were significantly more task focused and ‘produced more novel ideas compared to f2f groups’

However, there is a potential conflict between the need for ill-structured tasks because these are likely to maximise group interaction, and the demands such tasks place on the group members. A more structured task is likely to lower the level of collaboration. A more complex learning task may overwhelm learners when combined with the other demands of online group work, e.g. explaining, negotiating, elaborating, arguing, etc. (Cohen, 1994; Dillenbourg, 1999; Erkens, Andriessen and Peters, 2003).

The suggested solution is to find a middle ground between these two positions by keeping the group task ill-structured, but also focusing on scaffolding and supporting the collaborative process (e.g.; Cho and Jonassen, 2002; Ge and Land, 2003; Hmelo-Silver, 2004).

The development of more structured guidelines in this research helped to provide the scaffolding and to provide the learners with support while continuing to enable the groups to work on ill-structured and complex problems.

Johnson (2005) also found that those with the fewest postings achieved the lowest grades but that those with the highest did not necessarily achieve the highest grades. He suggested that low levels of postings limited learners’ involvements in the learning process but that excessive postings may reduce the time available for other types of learning. He suggested that this may also lead some learners to conclude that adequate involvement in the learning process is happening because of the large number of posts. I also identified this as a concern and my solution was the development of more formal guidelines on the number and type of posts and the total word count expected.
7.2.3 Formative feedback

Nulden and Hardless (1999) point out that online learning courses are more effective when the learner is provided with formative, effective feedback. Crook (2001) also argues that the purpose of formative feedback is to enhance learning, because this type of feedback gives the learner the opportunity to see if they are underachieving and to alter their learning behaviour if they wish. It also enables the teacher to detect learning problems. However, providing regular feedback to a large cohort of students can result in overload for the teacher (Otsuka and da Rocha, 2002).

Lupiccini (2007) also concludes that ‘with few exceptions … opportunities for learners to analyze their own interactions or group dynamics were rarely addressed in the existing research’.

Educational feedback can also be categorised as reference- or criterion-based. Criterion-based feedback is about giving the learner feedback on their achievement as compared to a pre-defined objective. Reference-based feedback shows the learner how they compare to other learners in the class or group.

There are arguments in favour of both types of feedback. Whichever type is used can motivate or de-motivate the learner, but the balance favours making all this feedback available.

Kay (1997) argues that by gathering together the data on usage of the VLE, what is in fact happening is that a model of the learner is being externalised. Kay has also suggested that externalising this model for the learner can help them identify learning goals and follow their progress when attempting to reach those goals. Mabbot and Bull (2004) argue that it can also make the learner aware of issues that they might not have thought about had the feedback mechanism not been available.

Bull and Ngheim (2002) point out that by allowing a learner to see models of other students, this can in turn help them to assess their own progress. Data from ‘good’ students can be used as an
objective, whereas data from weaker learners can provide comfort on their own performance. The class average indicates the ‘norm’ for the cohort.

Generally, only the lecturer of a course knows how students are doing, in other words, the student model. Externalising the student model, that is, offering students a view of their current knowledge, makes them more aware of their own learning and how they can affect it. Kay (1997) also argues that self-knowledge encourages reflection, and gives the student more responsibility for their own learning, which can in turn make learning more effective. It helps students understand their progress.

7.2.4 Assessing individuals in group-based projects
Rosen (1996) suggests that there are fundamental issues to consider in assessing individual contributions in a group-based project. Firstly, a lecturer’s awareness of the group processes maybe incomplete unless the tutor is in attendance at each group meeting or interaction. Secondly, the achievements of any one member may be dependent on others’ contributions. These two factors combine to create a third, which is the difficulty of assessing individual contributions (Slavin, 1990). It would be unfair to penalise the marks of some group members because of the lack of contribution by others, or alternatively to reward some members because of the efforts of others.

Students are individually motivated in their approach to assessment: they are concerned about their own grades more so than those of others. As Rosen states:

*They do not therefore take kindly to the notion that their assessment is reliant on the performance of others. In some ways, it is disingenuous to expect them to partake in group activities at all. Many students would argue that they are not attending the institution for that purpose. On the whole they accept that they must participate in the group project because the rules of the course specify that they must, but by and large they still expect their individual contribution to be judiciously rewarded.*

Therefore, how to assess individual contributions in a group-based assignment is problematic. Some solutions suggested are:

- group behaviour assessment by the lecturer (Jones et al, 1998)
  - requires lecturer to keep close check on group behaviour
• provides support for group
• judgement may be subjective
• difficult to verify marks given
• grades may be based on perceptions and may not truly reflect reality
• grading is most difficult when group has problems
• tension between requirement of groupwork and individual motivation can mean that some members may become scapegoats regardless of their competences
• lecturer is responsible for using the group-based approach therefore there is an onus on the tutor to ensure it works without compromising potential individual reward

• joint assessment by peer and lecturer (Rosen, 1996)
  • uses individual contribution sheet where students allocate percentage of marks to be awarded to each member of the group and is signed by all group members
  • draws on the knowledge students have of who worked hard and who did not
  • problem of students who collaborate to ensure all in the group get positive feedback
  • potential for damage to interpersonal relationships might also affect how individual learners grade others in the group

• shared group grade in single assignment (Poulter, 2008)
  • encourages groupwork
  • decreases likelihood of plagiarism which is more likely in individual assignments
  • relatively straightforward
  • individual contributions are not necessarily reflected in the marks
  • stronger students may be disadvantaged by weaker members or vice versa

• group average grade with individual submissions (Poulter, 2008)
  • group members receive the average of the marks for each individual submission
  • can motivate students to focus on both individual and group work
  • stronger students may be disadvantaged by weaker members or vice versa
allocate to individuals both a group and an individual mark. The final mark should weight the group performance more heavily to encourage collective effort (Poulter, 2008)

- relatively objective method of encouraging individual participation
- provides additional motivation to group members
- rewards higher levels of performance
- dependencies between tasks may slow progress in some areas
- may reduce the level of group collaboration if individual tasks are not inter-linked

I decided to adopt the final option in the above list as this approach fitted in best with the methodology I was developing. The only potential problem with this option was the fact that the group project consisted of a set of strongly interlinked tasks (ethical debate and discussion).

However, the method I had developed allowed for members of the group to continue working even if others did not contribute (see section 7.1.2.33 above for discussion on this).

### 7.2.5 Data visualisation

Data visualisation (DV) is the graphical representation of data and aims to abstract meaning by analysing large data sets and presenting their content in a graphical form. Charts and graphs are common types of DV.

Graphical representations of data are easier to understand than text or tables as the user can see chunks of data instead of individual items. Wright (1999) has shown that image processing and pattern recognition are two strengths of the human cognitive system, but that processing large amounts of tabular or text data increases the likelihood of misinterpretation or missed information because of cognitive overload. Mazza (2004) points out that graphical representations should show facts about data to reveal or abstract the real meaning and offer the user new insights. The goal of DV then, is to help reasoning about data by freeing mental resources such as memory and allowing lecturers and students to find patterns and identify relationships in large data sets.
To do so while remaining true to the data Tufte (2001) advises to keep in mind ‘the question at the heart of quantitative thinking: ‘compared to what?’ We should always keep in mind what we are using the data for, and what information we want to get out of it. In this project, it was to give formative feedback to students and to let lecturers know how students were performing as the course continued. A good visualisation also enabled the viewer to get the big picture at one glance and see the details when taking the time to look at its different parts, as expressed by Tufte's (1990) idea of micro and macro reading.

DV for educational feedback has specific advantages because it enables the aggregation of large amounts of data in one place, thus making it easy to find, while making the meaning of data stand out and the information easier to understand. But Otsuka et al (2002) have pointed to the danger of cognitive overload for lecturers if too much data is available for interpretation. Making the feedback easier to understand and the abstraction of meaning easier to achieve thus seems to provide a valid extra dimension to this study.

7.3 Critical reflection on Cycle 3
In this final cycle of action research I concluded my current study. I drew together a number of themes from earlier cycles and built on previous research outcomes.

I started the cycle by identifying a new VLE, Moodle, which provided extra functions which allowed me to develop my research themes. Because it was designed from a constructivist philosophy the functionality was more closely aligned with my requirements.

The need for new collaboration partners enabled me to generalize my research to see if the proposed pedagogy would work with other students and faculty in other institutions. I also had to re-visit my existing guidelines as new faculty required more information before committing to collaborating. I therefore needed to more fully explain the multi-institutional collaboration to these new partners and continue to identify any constraints.
I continued to develop the guidelines for students to support them in the online discussions, which most had not used in education previously. This was done by the introduction of a more formal description of the quantity and quality of posts. I also devised a calendar of activities to support the establishment and maintenance of virtual learning groups.

I adapted the CP framework in the light of student feedback and analysis of posts to more closely reflect the PISE domain.

Following further student feedback I identified a need for formative feedback. I used the CP framework of categorizing posts to develop a Moodle scale, which I used to rate each post. The data from this was then made available to students.

There was student feedback that requested criterion-based formative feedback. I determined to develop my own add-on to produce this as there was no existing facility in Moodle for this function. An investigation of data visualization led me to decide that all data for feedback would be better if it could be displayed graphically. This led to the design of DVReport.

DVReport has proved to be an overwhelming success. My feedback has been totally positive.

The guidelines I have developed for lecturers, potential collaborators and students have been a positive contribution to the field. Student feedback and my personal reflection indicate that the way in which I use ICT to support learning in a multi-institutional collaboration contributes to the achievement of learning outcomes and higher-order critical thinking for learners. It also enables lecturers to use a group-based pedagogy with large cohorts.

Finally, I believe that the DVReport, by using data visualisation, enhances formative feedback for students and enables lecturers to more easily see how individual learners are performing. These latter factors further contribute to the enhancement of learning for students working collaboratively in the domain of PISE.
8 Conclusion

8.1 Introduction
This study was instigated because of a pragmatic need to facilitate teaching and learning using a group-based pedagogy in a large cohort studying PISE. The methodology was difficult to apply due to the cohort size, even though the research literature supported this approach. This led to the development of the main research question of the study:

*Can the use of ICT enhance learning experience of students working collaboratively in the domain of PISE?*

The introduction of ICT to support teaching and learning in PISE in the first cycle of research dramatically improved the management of a large cohort of learners and indicated that there were benefits to the learning experienced by students. However, new issues arose which led to successive action research cycles to answer further research question.

In this chapter the main findings of the research are summarized, conclusions are discussed and future directions are suggested. Further, detailed, critical reflection has been included in chapters 5 to 7.

8.2 Online discussions to enhance learning
The use of discussions in a group-based learning environment was known to enhance learning in discursive domains similar to PISE, especially in relation to ethics in business and medicine. This was the rationale for using this pedagogy in PISE. However, problems with ‘free-riding’ and individual assessment in a group-based assignment meant that there were significant problems with this approach. Added to this were difficulties working with large cohorts and the time required for lecturers to read and assess student work.

The main research focus of this study has found that the use of a VLE in PISE does enable the learner to gain from this approach. At the same time the research addressed the concerns raised by
stakeholders as discussed in Chapter 4. There are significant potential difficulties in implementing the group-based pedagogy supported by ICT and the development of guidelines for teachers and learners was one significant outcome from this research. By following guidelines both teachers and learners are more likely to succeed in using VLEs to facilitate online discussions and enhance learning.

In summary the main research themes of this study were:

- Development of a multi-institutional dimension and guidelines to support the use of VLEs in PISE
- Methods to build and sustain online learning groups
- Identification of skills needed to engage in academic online discussion and development of guidelines for learners in this.
- Measuring learning and using data visualization to support formative feedback

Feedback from students indicated a major problem, i.e. the inauthentic nature of using computer-mediated online discussions with groups who were co-located. This led to the development of further research phases to deal with this issue which is discussed in the section below.

8.3 Development of a multi-institutional dimension and guidelines to support the use of VLEs in PISE

Feedback from students had identified the need for an authentic context in which to use online discussions for teaching and learning in PISE. There must be a demonstrable need for using ICT to support learning otherwise learners may not fully engage with the process. Students from a single institution do not see why they should use tools and methods that are designed to facilitate geographically dispersed groups.

Research in the area of computer-supported collaborative work had already identified the benefit of using online discussions. There was also research into computer-supported collaborative learning
(CSCL), and the use of similar methods in supporting group discussion in education. However, there was little or no work on using geographically dispersed groups in assessment in the domain of PISE or a related subject area.

Following further research into CSCL this led to a new research theme in this study using a multi-institutional approach to teaching and learning in PISE, and specifically the area of assessing student learning achievement. Although there has been a good deal of research into different aspects of multi-institutional collaboration in third level education, this has focussed on collaboration in research and in teaching. I was not able to find any examples of collaboration in assessment when I started this research. This meant that guidelines and techniques had to be developed to address issues that arose while implementing this approach.

Among the important findings from this research theme was the need to have clearly defined expectations and constraints for potential collaborators. Formal guidelines were developed which can be adapted and used by others planning multi-institutional collaboration in teaching and assessment.

A further outcome from this theme was the need to develop guidelines and procedures for faculty and learners using this approach. Feedback from students and faculty through a number of iterations of research led to the development of further guidelines on:

- the use of online discussion boards
- management issues such as calendars, timings and weightings for assignments
- development of parameters for learners to enable them to allocate sufficient time and effort to this method of teaching and learning

This research theme was revisited with different collaborating partners. Each cycle developed methods and led to enhanced guidelines. However, the basic approach was successful and the involvement of different partners shows that the multi-institutional approach is generalisable.
Although there were a number of specific outcomes from this area of the research there were other problems that became manifest in the manner in which learners worked in virtual groups. These are discussed in the next section.

8.4 Developing guidelines for learners on using academic online discussions

I identified a major while issue using online discussion boards in PISE. Students did not have the necessary skills to use this communication channel effectively. There were several issues here that needed addressing including:

- how to communicate effectively in this medium
- how to develop a threaded discussion
- types of posts that could develop a discussion
- posts that demonstrated critical thinking and analysis
- need for asynchronous communication

These issues were investigated over several cycles and by using student feedback and analysis of posts, formal guidelines and teaching input were developed. For online discussions to be a useful tool in learning and assessment, learners need to develop specific skills that may need to be taught. The formal guidelines developed as a result of this research theme can help to address this.

8.5 Methods to build and sustain online learning groups

Although the research showed that the use of ICT to support geographically dispersed groups had been developing in the work environment, there was little in the way of guidelines for students and faculty in the education field. This then became a further focus of this research study.

A number of problems had been identified in the early phases of the multi-institutional collaborations. These included:

- Difficulties learners had building and sustaining learning groups
- Problems in using online forums and building meaningful threaded discussions
• Allocation by students of sufficient time and regular interaction with fellow group members

These problems became apparent over a period of several cycles of teaching/research and led to the development of further guidelines and procedures.

These guidelines included the development of specific tasks to help build online learning groups using exercises to encourage socialisation. Clearly defined parameters relating to size and frequency of posts were developed so that students and faculty were clear about what was required. Tips and examples on how to build and sustain online discussions were also established using feedback from learners on each version to help improve these.

The outcomes from this research theme are contained in appendices 5.1 to 5.3 and will again be a useful tool for those intending to use this pedagogy in their teaching and assessment.

8.6 Measuring learning and using data visualization to support formative feedback

Deconstructing my core research question led to the need to identify measures that determine if enhancement in the learning process is occurring. This was the focus of this theme of the research study.

As was discussed in Chapter 3 both qualitative data and quantitative data were used for meaningmaking (Knight, 2002). The first type of data came from entries in my journal in the form of comments from individuals and focus groups. The second was based on analyses of usage patterns in the VLE, and comparison of grades for assignments over a number of cycles. While the data did suggest some trends, it became clear that it was inconclusive in answering the core research question. This led to a new research theme focussing on methods of measuring learning. (An unforeseen outcome of this theme was the eventual use of data as formative and eventually summative feedback for learners and the development of a more useful method to present this to all users with data visualisation.)
Initially to measure learning the Moral Judgment Test (MJT) (Lind, 2002) was used because of its proven track record in measuring improvement in moral reasoning. However, this proved to be not totally successful due to a number of reasons including student unwillingness to complete pre- and post-teaching questionnaires.

A further method of assessing posts in online discussions was then applied: the Community of Inquiry (CoI) (Anderson et al, 2001). One aspect of this approach to measuring critical thinking in online discussion is Cognitive Presence (CP). While CP offered some potential it needed adapting to the PISE domain. This was achieved over further cycles of research and teaching and the resulting final, and current version, was the outcome from this research. Feedback from learners supports my contention that this is an appropriate instrument to measure development of critical thinking in online discussions providing it is suitably adapted for a specific domain.

It also became evident that students required formative feedback on their ongoing discussions, and it became apparent that an extra function for the CP instrument was required became apparent – to assess posts. There was also a further reason for having this as one of the research themes, the need to assess individual contributions to groupwork.

This led to the development of a marking scheme based on the CP categorisation of posts. Although CP has been widely used in research, this was the first time it had been used to assess students and thus provide feedback for formative and summative assessment.

A further part of this research theme was the development of the allocation of marks for group and individual contributions. By adjusting the percentage of marks given for the individual contribution as measured using the CP, and those given to the group for the final report, individual contributions could be measured and rewarded in the final grade. The issue of measuring individual contributions in group-based assessment tasks had been an initial driver for this study. Developing a solution was an important outcome.
Although the outcomes from this theme were providing answers to further research questions, as often happens in research, further problems were identified.

Moodle provided a very comprehensive method to allow users, learners and lecturers, to be aware of progress by having access to formative feedback. However, this was produced in the form of tables which, with the size of cohorts in the PISE module, were extremely large. For the lecturer there were many hundreds of entries to be read and understood. For the learner there was no norm-referenced feedback. A further research theme was then developed, to design a new Moodle block that offered the functionality of providing norm-referenced feedback for learners and to also produce data for learners and lecturers that allowed easy abstraction of meaning.

Research in the area of data visualization showed that the use of graphical representation assisted the understanding of large data sets. However, there was no research indicating the use of DV in education. I therefore designed a specific tool, DVReport, to enable the student learning data to be made available in a more easily understood representation.

The outcome from this final phase of the research study enabled the student to easily see their progress by access to both criterion- and norm-referenced formative feedback. For the lecturer, data visualisation made it possible to identify those learners who were performing less well than others in the class and for timely intervention to take place.

DVReport has proved to be an overwhelming success for both learners and tutors and is a further, important, outcome of this research.

8.7 Developments in technology

This research study has taken place over eight years and in that time there have been significant developments in technology including a large number of developments in ICT, and new tools offer many more opportunities for further research. The whole area of Web 2.0 is one such. So it is valid to ask if this research still has validity.
Although the development of social networking tools offers new opportunities for using ICT in teaching and learning, I believe that outcomes from my research have applicability here. For example, the building and sustaining of virtual groups is a common theme to my research and to the newer technologies. Regardless of whether a learner is using a text-based discussion forum or a social networking site, the need to have a functioning group is the same. The guidelines I have developed are therefore applicable in this Web 2.0 approach.

The developments in ICT over the past eight years in industry (and education for that matter) does not mean that the need to produce written reports, often as part of a team or group, has disappeared. And students leaving third level education without the requisite skills to deal with this will be disadvantaged. The growth in globalised and distributed work practices means that skills to enable our students to function in this way are an ongoing requirement. The methods I have developed in this research will help support the development of these skills.

So, although ICT has progressed while this research has been continuing, many of the outcomes from my research are still valid and will continue to be so even with newer technologies.

8.8 Future directions
This research study has been continuing over eight years. A number of research phases have taken place and outcomes from these have become a framework for the integration of VLE into modules such as PISE.

The multi-institutional approach to teaching and learning in PISE was conducted among universities in Ireland, England, Malta and USA. All these countries share similar cultural, religious and legal systems. However millions of students are learning in colleges that are embedded in very different cultural and moral frameworks. It is a proposed future direction of this researcher to explore possible multi-cultural collaboration with institutions in other, culturally diverse part of the world with an emphasis on Asia and Africa.
Finally, the design of DVReport demonstrated the potential for using data visualization to abstract meaning from large data sets for formative feedback in an education setting. This tool was designed for the specific requirements of PISE and further developments could focus on the creation of a more generic tool that could be used with different assessment instruments.
Appendices
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274


276


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Thorndike, E.L. (1913) Educational Psychology: the psychology of learning, New York: Teachers College Press.


Appendix 4_0: Justifying PISE in the CS programme

The importance of continuing with PISE as a core module in the CSIS programme was supported by my research in computing curricula.

Following lengthy consultation, teaching computer ethics had been given a high priority in the Australian Computer Society’s Core Body of Knowledge (Underwood 1997). This outlined the content for a typical CS degree programme. The teaching of computer ethics courses became mandatory as a result for all professional level courses taught in third level in Australia (Staehr et al, 1999).

In 2001 two further professional bodies, the Association for Computing Machinery (ACM) and IEEE Computer Society produced a joint report on computing curricula. These two bodies were the largest representative organisations for computer professionals in the world, and their membership consisted of academic as well as business computer professionals. Once again there was a strong recommendation for the inclusion of a Professional Issues module as a core component in a CS degree programme. The Joint Task Force on Computing Curricula of IEEE and the ACM also strongly emphasised the need for core modules on Professional Issues in all courses accredited by either organisation.

There was also support from other professional bodies such as the Accreditation Board for Engineering and Technology (2000) that argued that professional issues should be a mandatory core part of all engineering degrees.

The ACM has continued its work on curriculum development publishing regular updates on its website cited below.

Computer Science Curriculum 2008: An Interim Revision of CS 2001
http://www2.computer.org/portal/web/education
Scoring Rubric for Group Grade (individual marks allocated as per ‘Assessing Posts’ document in Moodle)

The aim is to give a grade to the group for the report but to vary the individual grade depending on the contribution each group member makes. To calculate the group grade the objective percentage (e.g. Purpose and Organization - 20%) is multiplied by the grade band (e.g. Above Average - 65%). In this case giving 13% overall. The statements below show the likely grade band for each objective component.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Unsatisfactory</th>
<th>Satisfactory</th>
<th>Meets Expectations</th>
<th>Above Average</th>
<th>Exceeds Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Writing ethics papers</td>
<td>&lt;=39%</td>
<td>40% - 49%</td>
<td>50% - 59%</td>
<td>60% - 69%</td>
<td>75% - 100%</td>
</tr>
<tr>
<td>Purpose &amp; organisation 20%</td>
<td>Objective not clearly stated, paper lacks central focus</td>
<td>Satisfactory attempt at stating the objectives and focussing the paper.</td>
<td>Objective adequately stated paper has central focus</td>
<td>Objective clearly stated, paper has good central focus</td>
<td>Objective very clearly stated, paper has strong central focus</td>
</tr>
<tr>
<td>Focus (in introduction)</td>
<td>Lack of awareness of main ideas or wrong interpretation of main ideas</td>
<td>Covers basic subject matter adequately but insufficiently analytical.</td>
<td>Some awareness of main ideas and some critical analysis</td>
<td>Good awareness of main ideas. Clear evidence of critical judgement</td>
<td>An authoritative grasp of the main ideas, significant originality and insight</td>
</tr>
<tr>
<td>Significance (shows an awareness of main ideas)</td>
<td>Doesn’t write on topic</td>
<td>Mostly sticks to assigned topic</td>
<td>Meets all assignment criteria</td>
<td>Exceeds all assignment criteria, giving significant originality and insight</td>
<td>Strong Introduction &amp; Conclusion evidencing critical/analytical thinking, agree to agree or agree to disagree</td>
</tr>
<tr>
<td></td>
<td>No clear Intro &amp;/or Conclusion</td>
<td>Satisfactory attempts at providing an Introduction &amp;/or Conclusion</td>
<td>Good Introduction &amp; Conclusion that reveal insight and some originality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Introduction and Conclusion</td>
<td>Sources are inadequate</td>
<td>Sources adequate. Some minor inaccuracies.</td>
<td>Most statements are accurate.</td>
<td>Statements are very accurate</td>
<td>Statements are very accurate</td>
</tr>
<tr>
<td>Evidence 30%</td>
<td>Inaccurate statements made.</td>
<td>Satisfactory attempt to support opinions</td>
<td>Adequate support for statements/opinions</td>
<td>Good support for statements/opinions</td>
<td>Strong support for statements/opinions</td>
</tr>
<tr>
<td>Accuracy (statements)</td>
<td>Lack of support for statements/opinions</td>
<td>Some sources are identified and referenced appropriately in the body</td>
<td>Most sources are identified and referenced appropriately in the body</td>
<td>All sources are identified and referenced appropriately in the body.</td>
<td>All sources are identified and referenced appropriately in the body.</td>
</tr>
<tr>
<td>Support (opinions are adequately supported)</td>
<td>No sources identified in the body</td>
<td>Makes good use of ethical and social analysis and theories</td>
<td>Uses ethical and social analysis and theories convincingly.</td>
<td>Critically evaluates and uses ethical and social analysis and theories convincingly.</td>
<td></td>
</tr>
<tr>
<td>Social/Ethical Analysis (ethical frameworks)</td>
<td>Doesn't make use of ethical &amp; social analysis and theories</td>
<td>Minimally &amp; unconvincingly uses ethical &amp; social analysis and theories</td>
<td>Makes good use of ethical and social analysis and theories.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sentence structure (grammar, sentence structure, spelling, punctuation)</td>
<td>Poor appearance of Paper, No References included or References incorrectly laid out.</td>
<td>Acceptable appearance of Paper, References included and correctly laid out.</td>
<td>Good appearance of Paper, References included and correctly laid out.</td>
<td>Very Good appearance of Paper, all References suitably included and correctly laid out.</td>
<td>Excellent appearance of Paper, all References presented in standard, consistent format.</td>
</tr>
</tbody>
</table>

1 Appendix 5_0 Scoring Rubric
1 Appendix 5_1: Blackboard functionality and tools

In this section I will describe the functional components of the Blackboard (Bb) system.

Bb is an integrated set of web-based tools designed for the creation and management of a learning environment. These tools include:

- course development and management tools for setting up course sites
- content management tools to allow module content to be uploaded to the server
- communication and collaboration tools for communication between lecturers and students or for student-student communication
- assessment tools for marking quizzes and recording grades from other assignments
- personal information management tools for individual web pages
- academic web resources linked to other web sites and internet resources
- system management tools for administrators of the course site

Using these tools the following facilities are available;

- publication of learning materials (including links to module related websites)
- publication of announcements
- provision of a range collaborative tools including bulletin boards and chat rooms
- communication tools including email

Bb can be categorised into five distinct functional areas (as distinct to the buttons that appear in Fig 1 below):

- Content
- Communication
- Group Pages
- Student tools
- Administration

These are now described.

1.1 Content

The Content page was the course main screen. It was organised into two distinct areas. On the left are a series of navigation buttons and on the right the main display area.
The buttons and their functions of the Content page are:

- Announcements - these appear at login and can be constrained to show a subset of all announcements
- Course information - syllabus, course overview
- Staff information - contact details etc.
- Course documents - used to provide access to lecture material and supplements
- Assignments - assignment details and updates
- Communication - displays further options
- External links - links to course related websites
- Student tools
- Electric blackboard - whiteboard facility
- Resources - links to resources provided by blackboard including database of articles, bulletin board for academics, e-learning software provided by third parties etc
- Control panel
- My Blackboard - used to set up personal access options for Blackboard system.

The set of external links option enabled me to highlight particularly important links for the module. With the increasing size of the internet and the growth in the number and range of resources available having a pre-defined set of links helped to guide students to some of the more useful websites.
The Communication section (Figure 3 below) included the following functions at the course and cohort level:

- Send EMail to tutors and other students
- postings to main course Discussion Board, accessible to all on the course
- course Virtual Chat (disabled for most of the module due to technical problems with bandwidth) individual groups also had access to their own virtual chat tool
- Student Roster for timetables etc.
- Student Pages (the Student Pages was not available as this was for personal profiles and was not needed at this time)
- Group Pages.

The main course discussion board was primarily used to manage the module. Initially students were required to organise themselves into groups, select topics for presentations and reports, select
presentation slots and select tutorial slots. Groups coalesced around one or two individuals who had selected topics and who ‘advertised’ their requirements for extra members as needed. Use of this part of the system decreased as these management issues were resolved.

1.3 Group pages

As was mentioned above, the Group Pages (Figure 4 below) were accessed from the ‘Communication Center’

![Group Pages: Group J](image)

Figure 4 Group Pages (identities have been changed)

Access to all other parts of the course site is still available using the buttons on the left side but specific Group tools are accessed using the buttons along the bottom of the screen. Group members are listed in the main area. Only members of a particular group and the module tutor could access a group's tools.

Collaboration was achieved by students working in groups using functions provided from the Group Pages. The Discussion Board provided asynchronous communication (see below) and was the most used tool.

Virtual chat provided an internet relay chat (IRC) facility. Due to problems with bandwidth and access to an oftentimes busy Bb server this was not much used.

The File Exchange enabled students in a group to use a ‘digital drop box’ where files could be left for later access by other group members. Again this was not a much used facility as it was also possible to attach files to posts in the discussion board and users preferred this way of exchanging files.

Finally, users could send emails to all other members of the group using this fourth function. This was also not much used.

The Group Pages section became more used as the module progressed with peaks occurring before groups had to submit reports or do a presentation (the second assignment for the module). Figure 5
below shows a typical section from the Group Discussion Board. Usage of the Group Pages is detailed in Table 6.9 below.

**Figure 5** Group Discussion Board

### 1.4 Student Tools

The Final area of Bb, the **Student Tools** section was least used of the four main functional areas as there were relatively few features here that were needed to successfully complete this module. Student Tools included:

**Figure 6** Student Tools

- Drop box is a file upload facility e.g electronic assignment submission
- Homepage editing tools
- Change personal information
- Student calendar
- Check grade
- Student manual - on line manual for Blackboard
• Electric whiteboard - on-line shared whiteboard

1.5 Administration

The Administration functional area contained tools available to course tutors and course site administrators. These were available through the Control Panel (Figure 7 below).

The tools that were available to teachers and administrators provided the following functions:

• add/amend content
• add/remove/modify student/group details
• generate assessment tasks
• communicate with users, update module/course calendar, share files
• generate course statistics (see below)
• access to on-line manuals and help desk
• establish links with other faculty teaching similar subjects
• other site management tools

One particularly important tool from the research perspective was the Course Statistics tool (Figure 8 below), which enabled some quantitative analyse of how the different parts of the course site were used.
Statistics were provided on any one of the four functional areas, Content, Communication, Groups or Students. More precise statistics could be given for any sub-area of these four main areas.

Although counting the page hits on different sections of the course site was a crude measure of student behaviour, it did provide an initial level of analysis in the early phases of this research.
1 Appendix 5_2: Course descriptions for first collaborating partners

1.1 Sacred Heart University

“CEST is a full semester course (13 weeks) for senior computer science/information technology majors. Its objective is to address a number of issues that arise at the intersection of computers, technology and society and examines how the digital revolution has affected our personal and professional ethics. It is divided into three main areas:

• Perspectives
• Issues Regarding Access and Control
• Impact on Human Life.

"In Perspectives students learn about the ethical process: how to construct an ethical argument working from observations through assumptions and value judgments. They study theories of philosophical ethics: virtue ethics, utilitarianism and deontological ethics and use these to support their proposals. Finally, they examine the convergence of ethical and social analysis and try to come to some consensus about the role of technology in society and the place of computer ethics.

"In the section of the course devoted to access and control, students study the impact of the Internet on issues of privacy, computer crime, and hate web sites. They examine the question of property rights from intellectual property to open source and domain names.

"In the section on Impact on Human Life, students examine biometrics, identity and community (both virtual and real), workplace issues of reorganization, spying on employees, and whistle blowing. They examine the professional issues of errors, reliability and accountability in software/hardware development and discuss whether we are shaping computer technology for the betterment of society.

"Throughout the course, the professors foster the concept that to be an ethical computer professional, one must first be an ethical person. We follow the Aristotelian idea of flourishing personally and as a member of the professional community. I believe in using a constructivist approach to teaching and learning where the students develop their own ethical principles based on this.

"CEST is designed as a writing and oral communication course. Students are assessed on their writing and oral skills as well as the depth of their critical thinking and ethical arguments. They are required to write 5 half page papers on given topics using the ethical theories to support their points of view. In addition, there are 2 longer papers and one group presentation/paper based on a work of science fiction. Twenty percent of the student’s grade is based on participation online through Blackboard. This includes postings to a weekly threaded discussion board as well as a posting of directed reading questions about one of the articles we read in class. Based on these questions, that student will lead a discussion of the article. All written work is assessed through a developed rubric that is attached to submitted papers.
"In CEST, an asynchronous tool was required to implement a threaded discussion board that had previously been implemented by a listserv. In addition, students preferred the freedom that this tool provided in terms of accessing paper topics, their peers and the instructors as well as submitting papers in the digital drop box at their convenience.

1.2 de Montfort University

The PCICT module at De Montfort University (DMU) was originally developed for delivery to groups of Software Engineering students. The primary aim of this module is to highlight the fact that the activities of the ICT professional could potentially affect the working conditions and societal framework of everyone. Thus the teaching and learning strategy adopted was aimed at enabling students to become more aware of the fact that not only does the ICT professional wield great power and influence but that with this comes responsibility and accountability. This module therefore attempts to provide a framework within which such awareness can be achieved. The following five contexts are considered:

- Corporate
- Commercial
- Legal
- People
- Societal

The treatment of each context was designed to ensure that the student understood both the ethical issues involved and the role and responsibility he/she has within society. Students were encouraged to question their preconceptions about the role of the ICT professional both in work and society as a whole through debating contentious issues in a reasoned manner. Wherever possible, teaching material was case-based with examples drawn from real situations in order to illustrate particular issues, and in any ensuing debate students were required to draw upon the various ethical theories (teleological or deontological) to support their arguments. Lectures were used to provide a theoretical framework by covering both the ethical theories as well as a number of topics in each of the 5 contexts. For example – typical topics within each of the contexts are as follows:

<table>
<thead>
<tr>
<th>Context</th>
<th>Indicative topic areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corporate Context</td>
<td>The strategic planning process, Links with corporate objectives, Project selection, Economic feasibility</td>
</tr>
<tr>
<td>Commercial Context</td>
<td>The tendering mechanism, Product liability, Quality standards, Benchmarks</td>
</tr>
<tr>
<td>People Context</td>
<td>Project politics, Team roles, Relationships with different stakeholders</td>
</tr>
<tr>
<td>Societal Context</td>
<td>Moral and social implications of computer systems, Professionalism, Codes of Conduct</td>
</tr>
</tbody>
</table>

Table 1 The 5 contexts of the PCICT module at De Montfort University
1 Appendix 5.3: Pointers For Success In Virtual Group Work

Socialising
Research has shown that groups that socialise together work better as teams. Obviously you cannot do this as you are some distance apart. The next best thing is to tell each other about yourselves. So initially mention basic details about age, nationality, gender (and some of you may have first names where your gender is not immediately obvious). But you might also like to describe your college, the course structure, what other courses/modules you are doing. What type of family do you come from, any brothers or sisters? A bit about your social life might be of interest, maybe the last two fun things you did (as long as they were legal!), the last concert/band/play/movie you went to. What book you really liked. And remember also that some of your group members may not know what certain words or terms you use mean (so what is a 'junior' at a US college?)

Faculty biographies are available on Bb also. Look in the Staff Information section.

Organising
Each group should decide on the roles each member is going to adopt. So who will collate the final report? Who will be responsible for contacting faculty if there is a pressing question?

Planning
It might help if you put up information about your various vacations so that work can be scheduled to avoid unnecessary delays?

Discussion threads
We really want to see evidence of higher order critical or deep thinking. If somebody puts up a comment or question then a simple "I agree, the computer jury is quite a good topic to debate" for example doesn't really demonstrate this. A good argument is better than a simple statement of agreement.

Messenger
Yahoo Messenger is a much used tool that enables people to communicate synchronously over the internet. Some research has shown that it might be very helpful when groups are getting going. Maybe some of you might like to use these tools but make sure you choose a time that isn't the middle of the night for some people! If you do use such tools then can you mention it on your group discussion board.

Monitoring
The project you are part of (international collaboration) is investigating the use of tools like Blackboard in university teaching. All your postings will be seen by faculty but anonymity is assured. For assessment it might be better to start a separate thread just for the stuff you want to be graded. (You have the option of submitting a threaded discussion of a written report for the final assessment.) If there are any specific queries you have then we will pick these up when we visit your group discussion board (we plan to visit three or four times per week). If there is an urgent query you can notify any of us via email boxes and we will then visit your board as soon as we can.

Document versions
Please be sure to indicate which is the final version of any documents you are submitting for assessment. This is so we can differentiate working documents from the final version.

Attachments
In most cases it's better to embed your document in a message instead of submitting it as an attachment. It aids readability and making amendments are also easier. Obviously this doesn't work for really big docs.
Appendix 6_1: Computing the MJT's C-score

The C-score is computed analogously to multi-variate analysis of variance (MANOVA). It can be computed 'by hand' using a pocket calculator. For larger data sets, though, the use of a computer is strongly recommended. In most cases some programming is required because most commercial packages do not provide ready methods for analyzing data individually. However, most packages (like SAS, SPSS, STATISTICA) have a programming language module included that lets you quickly write a program that calculates scores for individual response pattern. The coding scheme for the standard version and a sample program for STATISTICA, version 4.x can be requested from the author. A scoring service is also available. For testing, there is also N=1 spreadsheet available using WordPerfect's table functions (see an example).

For calculation by hand, a sample calculation is given in Appendix B. To assign the MJT-items to the six stages, the coding scheme is needed.

If you do the calculation of C by hand, this is a good way to do it: First, calculate the Mean Sum of Square ($SS_M$). Add up all raw data for the arguments (24 items; "x" means that all raw data x's are to be added up); then square the sum and divide the sum by the number of items which constitute the mean (here the correct numerical are 24, the number of items of the standard version of the MJT). The result is the Mean Sum of Squares, which is roughly equivalent to the arithmetic mean.

Second, calculate the (adjusted) Total Deviation Sum of Squares ($SS_{Dev}$): Square all raw data $x \times x^2$. This is called the unadjusted total sum of squares. Then add up all $x^2$ and subtract from this the Means Sum of Squares. This is the $SS_{Total}$.

Third, calculate the (adjusted) Stage Sum of Squares ($SS_{Stage}$): Add up all four items that belong to a particular stage and square the sum. For example, for stage 1, the squared sum is:

$$(X_{1, worker, pro} + X_{1, worker, con} + X_{1, doctor, pro} + X_{1, doctor, con})^2.$$  

Repeat this for all six stages. Then add up these six squared sums and divide the result by four (the number of repeated measurement for each stage), which gives you the (unadjusted) stage sum of squares. After subtracting the Mean Sum of Squares from this number, you have the (adjusted) Stage Sum of Squares. [Note that before this, you need to sort the items according to the stages that they represent. The stage coding can be requested from the author.]

Now you have all information needed to calculate the C-index: first, divide the Stage Sum of Squares by the Total Deviation Sum of Squares: $SS_{Stage} / SS_{Dev}$. This is the coefficient of determination $r^2$. Multiply this number by 100, to get C.

There are several ways to check whether your calculation is correct, and they should all be considered to make sure that the calculations are technically correct:

- Recalculate everything once more. This should always be done if you do the calculation by hand or table calculator.
- Make plausibility-checks: The $SS_{Stage}$ must never be bigger than the $SS_{Dev}$. The $SS_{Mean}$ must never be bigger than the unadjusted $SS_{Total}$.
If you make a program to do the calculation for you on the computer: run trials with numbers that you can easily check by hand. Try several patterns of numbers like all "1," which should give you a "0" for all adjusted numbers, e.g., SS\textsubscript{Stage} and SS\textsubscript{Dev}, or all "1" for stages 1 to 3 and all "0" for stages 4 to 6. This should give you a high value for SS\textsubscript{Stage}.

To find and eliminate "bugs" in your program, the best way is to calculate the score again. If the results keep changing, review your calculation technique. Use the scheme below to calculate the C-index.

Errors may also occur when keying in the data. So double-check both. I have found that some spreadsheet programs make errors in adding simple numbers. My WordPerfect word processor does this sometimes. For example, when I enter a negative number, the minus sign is sometimes changed into a dash sign and then ignored by the program.

Some statistical packages also have a hard time doing what the programmers tell them to do. When you are not sure, do both things: a) compare the computer's calculations of a simple example with your hand-done calculations; try different number patterns because only then you can be fairly sure that the program works correctly; b) check the empirical findings using the criteria explained above in the section "Validating new and translated versions of the MJT." Both methods helped me to identify technical data errors.
1 Appendix 6_2: Guidelines for posting to discussions

Based on "Theory and Practice of Online Learning" by Terry Anderson published by Athabasca University in March 2004

Guidelines for posting to discussions

1. Please focus on the topics posted. But do bring in related thoughts and material, other readings, or questions that occur to you from the ongoing discussion.
2. You are expected to post at least two substantive messages or three or four smaller posts (about 450 words per person per week for three weeks) for assessment. Posts will be assessed according to the criteria on the next page. Each post will get just one rating. Your postings should reflect an understanding of the ethical theories as applied to the case studies. Each posting will be graded according to the analysis of cognitive presence (see next page). You may also post other messages which are for general communication purposes. These will not be assessed. So make sure that the assessed posts are in a separate thread and clearly identifiable.
3. Your postings should advance the group's negotiation of ideas and meanings about the case study, i.e. your contributions should go beyond a "ditto" or "I agree" type of responses. Some ways you can further the discussion include:
   (i) expressing opinions or observations - these should be offered in depth and supported by more than personal opinion, e.g. references.
   (ii) making a connection between the current discussion and previous discussions, a personal experience, or concepts from the readings, e.g. stating the arguments for and against a particular ethical theory.
   (iii) commenting on or asking for clarification of another student's statement.
   (iv) synthesizing other students' responses, or posing a substantive question aimed at furthering the group's understanding.

Nada Dabbagh (2000), from George Mason University, also offers a slightly more prescriptive set of recommendations for posting that you might find useful.
1. Postings should be evenly distributed during the discussion period (not concentrated all on one day or at the beginning and/or end of the period).
2. Postings should be a minimum of one short paragraph and a maximum of two paragraphs.
3. Avoid postings that are limited to "I agree" or "great idea," etc. If you agree (or disagree) with a posting then say why you agree by supporting your statement with concepts from ethical theories or by bringing in a related example.
4. Address the questions as much as possible (don't let the discussion stray).
5. Use quotes from books or journal articles that support your postings. Include references when you do that.
6. Build on others responses to create threads.
7. Bring in related prior knowledge (work experience, prior coursework, readings, etc.).
8. Use proper etiquette (proper language, typing, etc.).
Categories of postings (Analysis of cognitive presence)

The following are the description of the categories that will be used to rate your postings. Each post will be categorized in one of the four following ways. If you only post one large message then you will only get one opportunity to gain a mark. So remember, post two or three per week for the full three weeks giving you the opportunity to maximize your marks for individual contributions. See also the Report Marking scheme for this assignment. You should aim to get more of the Integration and Resolution type of posts.

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Indicator</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triggering events</td>
<td>Evocative</td>
<td>Recognizing the problem</td>
</tr>
<tr>
<td>Exploration</td>
<td>Tentative</td>
<td>Sense of puzzlement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Divergence within community</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Divergence within single message</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Information exchange</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suggestion for consideration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brainstorming</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leaps to conclusions</td>
</tr>
<tr>
<td>Integration</td>
<td>Provisional</td>
<td>Convergence among group members</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Convergence within single message</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Connecting ideas – synthesis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Creating solutions</td>
</tr>
<tr>
<td>Resolution</td>
<td>Committed</td>
<td>Vicarious application to real world solutions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Defending solutions</td>
</tr>
</tbody>
</table>

The full reference for the research is:
1 Appendix 6_3: MJT questionnaire

ID number: Group:

1. Workers’ Dilemma

Due to some seemingly unfounded dismissals, some factory workers suspect the managers of eavesdropping on their employees through an intercom system and using the information against them. The managers officially and emphatically deny this accusation. The union says it will only take action against the company when there is proof. Two workers then break into the admin office and take the tapes that prove the allegations of eavesdropping.

I strongly disagree I strongly agree

1. Would you disagree or agree with the workers’ behavior

I find the argument:

completely unacceptable completely acceptable

+2 +3

How acceptable do you find the following arguments in favour of the two workers’ behavior? Suppose someone argued they were right. I find the argument:

2. because they didn't cause much damage to the company

-4 -3 -2 -1 0 +1 +2 +3 +4

3. because due to the company's disregard for the law, the means used by the two workers were permissible to restore law and order

-4 -3 -2 -1 0 +1 +2 +3 +4

4. because most of the workers would approve of their deed and many of them would be happy about it

-4 -3 -2 -1 0 +1 +2 +3 +4

5. because trust between people and individual dignity count more than the firm's internal regulations

-4 -3 -2 -1 0 +1 +2 +3 +4

6. because the company had committed an injustice first, the two workers were justified in breaking into the offices

-4 -3 -2 -1 0 +1 +2 +3 +4

7. because the two workers saw no legal means of revealing the company's misuse of confidence, and therefore chose what they considered the lesser evil

-4 -3 -2 -1 0 +1 +2 +3 +4
How acceptable do you find the following arguments against the two workers’ behavior? Suppose someone argued they were wrong. I find the argument…

completely completely unacceptable

8. because we would endanger law and order in society if everyone acted as the two workers did. -4 -3 -2 -1 0 +1 +2 +3 +4

9. because one must not violate such a basic right as the right of property ownership and take the law into one’s own hands, unless some universal moral principle justifies doing so -4 -3 -2 -1 0 +1 +2 +3 +4

10. because risking dismissal from the company on behalf of other people is unwise -4 -3 -2 -1 0 +1 +2 +3 +4

11. because the two should have run through the legal channels at their disposal and not committed a serious violation of the law -4 -3 -2 -1 0 +1 +2 +3 +4

12. because one doesn’t steal and commit burglary if one wants to be considered a decent and honest person -4 -3 -2 -1 0 +1 +2 +3 +4

13. because the dismissals of the other employees did not affect them and thus they had no reason to steal the transcripts -4 -3 -2 -1 0 +1 +2 +3 +4

2. Doctor's Dilemma

A woman had cancer and she had no hope of being saved. She was in terrible pain and so weak that a large does of a pain killer such as morphine would have caused her death. During a temporary period of improvement, she begged the doctor to give her enough morphine to kill her. She said she could no longer stand the pain and would be dead in a few weeks anyway. The doctor granted her wish.

I strongly disagree

14. Do you disagree or agree with the doctor's behavior?  
\[
\begin{array}{cccc}
0 & +1 & +2 & +3 \\
-3 & -2 & -1 & \quad (\text{agree})
\end{array}
\]

How acceptable do you find the following arguments in favor of the doctor?

Suppose someone said he acted rightly. I find the argument completely unacceptable

15. because the doctor had to act according to his conscience. The woman's condition justified an exception to the moral obligation to preserve life

\[
\begin{array}{cccc}
-4 & -3 & -2 & -1 & 0 & +1 & +2 & +3 & +4 \\
\end{array}
\]

16. because the doctor was the only one who could fulfill the woman's wish; respect for her wish made him act as he did

\[
\begin{array}{cccc}
-4 & -3 & -2 & -1 & 0 & +1 & +2 & +3 & +4 \\
\end{array}
\]

17. because the doctor only did what the woman talked him into doing. He need not worry about unpleasant consequences.

\[
\begin{array}{cccc}
-4 & -3 & -2 & -1 & 0 & +1 & +2 & +3 & +4 \\
\end{array}
\]

18. because the woman would have died anyway and it didn't take much effort for him to give her an overdose of a painkiller.

\[
\begin{array}{cccc}
-4 & -3 & -2 & -1 & 0 & +1 & +2 & +3 & +4 \\
\end{array}
\]

19. because the doctor didn't really break a law. Nobody could have saved the woman and he only wanted to shorten her suffering

\[
\begin{array}{cccc}
-4 & -3 & -2 & -1 & 0 & +1 & +2 & +3 & +4 \\
\end{array}
\]

20. because most of his fellow doctors would presumably have done the same in a similar situation

\[
\begin{array}{cccc}
-4 & -3 & -2 & -1 & 0 & +1 & +2 & +3 & +4 \\
\end{array}
\]

300
How acceptable do you find the following arguments against the doctor? Suppose someone said that he acted wrongly. *I find the argument...*

<table>
<thead>
<tr>
<th>Argument</th>
<th>Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>21. Because he acted contrary to his colleagues’ convictions. If they are against mercy-killing the doctor shouldn't do it</td>
<td>-4 -3 -2 -1 0</td>
</tr>
<tr>
<td></td>
<td>+1 +2 +3 +4</td>
</tr>
<tr>
<td>22. Because one should be able to have complete faith in a doctor's devotion to preserving life even if someone with great pain would rather die</td>
<td>-4 -3 -2 -1 0</td>
</tr>
<tr>
<td></td>
<td>+1 +2 +3 +4</td>
</tr>
<tr>
<td>23. Because the protection of life is everyone's highest moral obligation. We have no clear moral criteria for distinguishing between mercy-killing and murder</td>
<td>-4 -3 -2 -1 0</td>
</tr>
<tr>
<td></td>
<td>+1 +2 +3 +4</td>
</tr>
<tr>
<td>24. Because the doctor could get himself into much trouble. They have already punished others for doing the same thing</td>
<td>-4 -3 -2 -1 0</td>
</tr>
<tr>
<td></td>
<td>+1 +2 +3 +4</td>
</tr>
<tr>
<td>25. Because he could have had it much easier if he had waited and not interfered with the woman's dying</td>
<td>-4 -3 -2 -1 0</td>
</tr>
<tr>
<td></td>
<td>+1 +2 +3 +4</td>
</tr>
<tr>
<td>26. Because the doctor broke the law. If one thinks that mercy-killing is illegal, then one should refuse such requests</td>
<td>4 -3 -2 -1 0</td>
</tr>
<tr>
<td></td>
<td>+1 +2 +3 +4</td>
</tr>
</tbody>
</table>

Thank you!
1 Appendix 7_1: Moodle Functionality

Moodle is based on a series of learning activities. The social constructionism philosophy that underpins its design has grown out of the constructivist paradigm. It promotes the idea that learners will reach higher levels of critical thinking by not only constructing knowledge but by creating artefacts. These artefacts can be created collaboratively using many of the tools (called activities) in Moodle.

The following is a list of some of the activities in Moodle which can be used as required depending on the teaching and assessment task being used.

- forums - a form of bulletin board
- content management (resources)
- quizzes with different kinds of questions
- blogs
- wikis
- instant messaging
- surveys
- glossaries
- peer assessment
- chat

When a course is in Moodle one or more of these activities will be incorporated.

Moodle also has a number of ‘roles’ each with different levels of permission. Thus the administrator role has all the permissions, teachers have fewer and so on down to the guest role which has only read permissions.
There are also facilities for including a range of learning resources on a Moodle course site. These can be text or web page files or links to files or websites. Figure 2 below shows the editing facility to allow activities or resources to be added to a course.

### 1.1 Using Moodle

Each course on Moodle was accessed from the main page on the Moodle server. Once the user clicked on a course, they were prompted to log in if they had not already done so. A typical course home page is shown in Figure 1 below.

![Course home page](image)

**Figure 1** A course home page (administrator role view)

The content of the course home page could be changed. Each of the rectangles is a Moodle block and the tutor can decided which to display and where they are displayed. In the above figure seven items can be seen. This view is dependent on the role of the user.

The People block allows for amending those enrolled on the course, add new users or updating profiles of current users. The Calendar block allows any entry to be updated by the lecturer.
Students can have update permissions to all or just some of the items depending on the settings. The Activites block on the left shows those Moodle activities used in the course. The other block on the right are self explanatory.

In the centre is the window for the main course components, the Topics Outline block. This contains a list of links to different parts of the Moodle course. These could be added once editing was turned on using the button in the top right.

The first three items in the Topics Outline block are forums. There are then two links to text documents followed by a link to a Word file. There is then a link to a glossary (see below). A quiz link is third from the bottom followed by a link to another website which could be displayed in a separate window if required. Finally there is a link to a hidden teacher forum which students would not be able to see.

Figure 2 below shows the main part of the block with the editing turned on.
Figure 2 Editing resources in Moodle.

Each item in the list could be edited using the icons next to the item. The first two allowed the administrator to indent or move the item to a new location in the course home page. An item could be edited, including changing settings by clicking on the hand icon. Items could be deleted or temporarily hidden by clicking on the X or eye symbol.

Some activities in Moodle could support group mode. The small person icon enabled the administrator to select from three group mode options:

- no groups or sub-groups
- separate groups where each group can only see their own input
- visible groups where each group can read other groups’ work but cannot contribute
These group options allowed for varying ways of setting up collaboration options and could be set at the course level or for particular activities.

The final two buttons allowed the administrator to add new resources or activities to a course. Depending on the course requirements the next part of the course home page could be shown as topics, as weeks or as a social networking set up. Figure 3 below shows a course that used the ‘weeks’ layout.

Figure 3 A course using the ‘weeks’ layout

For each week section the lecturer could add a comment or include specific resources or activities. The range of activities and resources available was constantly growing as Moodle was developed and as users developed new additions. Some of the tools I used are now discussed.
1.2 Forums
At the heart of Moodle is the activity known as the Forum. This is where online threaded
discussions can take place. However forums can be used in three different ways:

- as a general notice-board to convey information from lecture to the whole cohort
- to enable all members of the collaborating cohorts to communicate on any issue
- for groups to work in a private space that could only be seen by group members and tutors

Figure 4 below shows the tutor view of a forum. There were two options that I could use to
determine who was subscribed to the forum and thus which of the three ways it might be used. If I
required everybody to be subscribed, say for a News forum, then I selected the Force Everyone to
be subscribed. If I allowed users to choose to subscribe then the Subscribe/unsubscribe option was
available. Subscribed users received an email alert in every time there was a new post (see below).

Furthermore I could also determine what read and write permissions users had. For the News forum
students could not post, it was an electronic notice board I used for important announcements.

Combined with the option that forced everybody to be subscribed, I was able to ensure that every
time I posted something here an alert was sent to each subscriber.

Other permissions allowed users to:

- start a discussion
- only reply to a discussion
- only allow a single reply existing discussion

These could be used depending on the teaching task being used at any point during the course.
Figure 4 Forum in Moodle

Other set up options allowed forum posts to be tracked so that users could see from the main page if there were any new posts. So, even if a user was not subscribed they could see at a glance the status of activity in any forum.

A threaded discussion was shown in the first column with the thread originator’s details shown. Clicking on the thread title took the user to the discussion. Clicking on the user name produced a pop up to allow messages and or emails to be sent to that user. The next column showed the number of replies or thread length. Then the number of posts unread. The final column had a link to the last post in a discussion. Thus the user could either go directly to the first or last post in any threaded discussion from this view.

Once a user clicked on a post Moodle displayed the threaded discussion in one of a number of user-selected ways. Figure 5 shows one view.

The manner in which posts were displayed could be selected from the drop down menu in the centre. Individual posts in the thread could also be immediately displayed by clicking on the link.
Figure 5 Posts displayed in threaded form.

If a user preferred to see the entire posts rather than their titles in threaded form then this view could be selected. Figure 6 shows a threaded discussion in nested form.
Two other alternatives allowed the user to display posts in date order or reverse date order. Thus users were able to select the appropriate format of display to suit their needs and learning styles.

At all times the user had a number of navigation aids. The ‘breadcrumb’ allowed the user to go directly to an item further up the navigation tree. The Jump option allowed the user to go directly to any resource in the course.

Finally the Search forums button allowed the user to find posts that fulfilled certain search criteria.

As has already been noted, Bb had a cumbersome navigation system. As a result it was difficult to determine what interaction was going on. Moodle had an alerting system. By subscribing to a forum a user would receive an email alert (see Figure 7) every time somebody posted to that forum. (Users
could unsubscribe to avoid these alerts, as described above). This alert ensured that users were always aware of the level of activity in any forum to which they were subscribed.

Figure 7 Email alert from Moodle

The user was presented with a number of link options in the email alert. By clicking on any of the links it was possible to go directly to that point in the Moodle course. This enabled the users to access and/or respond quickly and efficiently to other posts.

Faculty could also have emails alert copied to their own email account and thus could be kept aware of learner activity. It also enabled the lecturer to see when intervention was required.

The email alert combined with the easy navigations option offered in Moodle was a significant improvement on Bb. It would make the use of this VLE quicker, more efficient and thus less of an obstacle to learning.

1.3 Other communication tools
There were further tools in Moodle that could be used for communication, over and above the forum. Communication from the lecturer could be to individuals or groups of students as was required. One or more users could be selected and emails or instant messages used for communication. The former was useful if I needed to contact a student who was offline. The latter
was used to provide an instant form of communication to those who were currently online, although its functionality overlapped emailing as a copy of the message was also emailed to the user.

Blogs and Wikis could be made available to users during the set up process. Both of these tools allowed the users to build common artefacts by contributing to other users’ blogs or wikis. It was an added method that allowed collaboration to take place and was yet another example of tools that were specifically able to support the constructivist pedagogy.

Chat facilities were available in Moodle but no contributions to these were assessed. However students liked using this form of synchronous communication, especially when getting to know each other in the social stage of group formation.

1.4 Glossaries

I used the Glossary activity to further encourage student engagement with the learning process and for collaboration. Figure 8 shows the glossaries section of Moodle.
I used glossaries to enable learners to create their own definitions of common terms in the context of PI and/or to comment on those definitions submitted by others. Once a glossary was created I received a notification and would approve the entry if it was OK or refer it back to the author. Once approved the glossary entry was added to the growing list. Students could add comments to an existing entry and this led to some glossary items being modified following discussion.
1.5 Administration

Administration functions can be carried out at the course level or site wide. These functions are available in the requisite administration panel. Figure 9 shows the site wide functional areas. These are only available to administrator role users who can ‘do anything anywhere’.

![Site Administration](image)

Figure 9 Site level administration functions

At the course level a further set of administration functions is provided as shown in Figure 10 below.
Anybody with a teacher role will have access to this set of tools and any changes required in a course can be done from here. The assign roles determines the permissions users have in a course. Any user can assign roles up to and including their own level.

The Reports function is what gives Moodle a major advantage of Bb. It is from this option that the course statistics are accessed as discussed next. These are provided as a series of logs.

1.6 Logs of use

Bb had a Course statistics tool to enable the lecturer to keep a track on student activity. However usage was determined by page hits and as such was a crude measure of activity.

The Moodle logs provided a comprehensive set of information for the learner and for the lecturer. This function showed the type of interaction a learner had with the system (Figure 11). Subsets of the logs could be displayed by selecting from any of the drop down menus. This would show which
components had been accessed and in the case of a forum, whether the user had just viewed or had posted to the forum. This data could be analysed by user, by time period and by resource.

Figure 11 Main Moodle logs page

Figure 12 below shows the logs for a single user. All the user’s activities are listed as well as the type of action.
Using the this feature in Moodle allowed me to see how different learners were interacting with the resources and with each other. I could assess how each group was performing a task and I could quickly identify which learners were contributing more, or less, than others. I could see who was just viewing posts and who was responding. This then gave me a significant amount of ongoing information on the level of activity in a course.

1.7 Rating posts

Ratings could be assigned to many activities. I used them in the forum. Either the lecturer or the student could rate posts depending on the permissions given. A lecturer could develop their own rating scale depending on the course and learning requirements. Figure 13 shows the Rating option on a post.
The drop down menu lists the items in the rating scale. This rating could be used to determine how a user was progressing. This in turn allowed for teaching intervention if required.

Figure 14 Grades list for users on course

Figure 14 above shows the output for a class of students with their ratings. I used this feature to provide me with feedback on learners. Rating of posts is discussed in Chapter 7.
Appendix 7_2: Invitation To Collaborate
Teaching Professional Issues with Multi-Institutional Collaboration

1.1 Introduction
For the past six years I have been involved in teaching Professional Issues (PI) to students at the University of Limerick (UL) and collaborating institutions in England and USA using a technique that involves collaborative learning and assessment. I define PI as the ethical, legal and social consequences of the design, implementation and use of computer and information systems.

In this collaborative approach students work together using online discussion tools in groups of about 6 (with 2 from each collaborating institution in each group) on a moral dilemma in the area of computer and information systems. They focus on the ethical consequences of behaving in a particular way. Individual group members take a particular ethical theory and apply that to the scenario and debate the merits of this theory against others in their group who are using a different ethical theory. At the conclusion of a three to four week period the group then collaboratively produces a final report outlining their findings. It is not necessary that the group arrives at the same conclusions, the process of collaboration, debate and discussion is what is important.

I have now developed a particular approach and identified certain constraints that could have a negative impact on outcomes. In this short document I outline these so potential partners can decide if they can collaborate with me and my students.

1.2 Student cohorts
Currently this PI module is taught to final year undergraduate computer science major students and also to postgraduate students studying Interactive Media. In the past the collaboration has taken place with undergraduate students who are also computer science majors, those studying Information Technology and on Business Computing courses. Technical expertise in computing is not a pre-requisite of this collaboration. In fact many of the Interactive Media students come from
an arts background and not a computing one. It would be preferable if students collaborated with others of roughly the same academic level, i.e. undergraduates work with other undergraduates and post-grads with post-grads.

1.3 Content
My PI course is taught using a mix of lectures and tutorials. For the first three/four weeks I give lectures on ethical theories and ethical analysis, details below. (This is then followed by lectures on legal and social issues, which are assessed using other instruments)

The first main objective is to show students what ethics is about and a range of different ethical theories. The aim of this part of the course is to provide the student with enough knowledge to be able to participate in an ethical discussion based on a moral dilemma and to enable students to develop the skills to partake in an ethical debate.

This is the typical content I cover in my lectures:

- What is ethics?
- Ethics: rational, systematic analysis
- Relativism - Subjective and cultural
- Divine Command Theory - Religious basis for ethics
- Kantianism - Immanuel Kant
- Utilitarianism - Bentham & Mill
- Social Contract Theory - Hobbes, Rousseau, Rawls
- Objectivism vs. Relativism
- Framework for Ethical Decision Making

1.4 Learning Management System
The LMS I currently use is called Moodle. Details can be found on http://moodle.org It is a free open source course management system. We have installed this on a server here in UL and it is
accessible by anybody with internet connections. It is very lightweight so works quite well with slower connections such as dial up. Collaborating students would need internet access but no other technical commitment would be needed from collaborating institutions.

Course materials from partner institutions would be uploaded to the Moodle server so that all students can see all material used in all participating institutions.

I have identified three possible constraints, timing issues, language issues and assessment issues. You may have others, please let me know.

1.5 *Timing issues*

A major constraint is that of timing of semesters. Universities have different academic calendars and holidays due to their geographical locations. In the Northern Hemisphere the academic calendar tends to have Autumn (Fall) and Spring semesters. But in parts of Asia there are long vacations in your summer which is our winter and Christmas break. In Australia the seasons are somewhat reversed to those in Europe and North America. For this project to be successful it is important that students are studying at approximately the same time in the academic year.

Here in UL I teach Professional Issues in the Spring semester. Next year this will be from [start date] until [end date]. So if your semester does not broadly overlap with this then it may not be possible for us to collaborate.

Our semester is 12 weeks long. On March 17th we celebrate St Patrick's Day, our national holiday. Then this is followed by our Easter break from [dates]. If you have a longer Easter Holiday period we may need to discuss this but it may not be a problem depending on the length of the break.

Students from collaborating institutions can start getting to know each other using Moodle during the first few weeks while the main theoretical frameworks are being covered in lectures. I have developed some exercises to help build virtual teams for this part of the collaboration.

Here is a typical outline of the collaboration period but can be altered to suit specific requirements.
<table>
<thead>
<tr>
<th>Task number</th>
<th>Week number</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>Students register with Moodle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Add/ update personal profile</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>Explore Moodle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>start a discussion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>reply to a discussion</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Form into groups</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Groups to socialise on-line</td>
</tr>
<tr>
<td></td>
<td></td>
<td>build up a group identity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>build up group trust</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>Select case study</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inform tutor of selection</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>Start assignment/discussion</td>
</tr>
<tr>
<td>7</td>
<td>8/9</td>
<td>Hand in completed assignment</td>
</tr>
</tbody>
</table>

The main divisions are:

- Introductory lectures on ethics and ethical theories while students get to know Moodle, form into virtual groups and select moral dilemmas for their assignment case study. First 3 weeks.
- Students work in their groups debating and discussing an ethical dilemma of their choice. During this period students are expected to submit up to 450 words per week to their discussions in three or more smaller posts. 3 to 4 weeks.
- Students agree a final report and hand this in. 1 week

Provided there is an overlap of about 8 weeks in teaching periods then it will be possible for collaboration to take place.

Finally, as communication is mainly by asynchronously there is no need for collaborating students to be in the same time zones.

1.6 Language issues

The module is taught in English and all collaborating students and lecturers need a good command of English. Each student will need to be able to write short essay type messages to add to the
discussions on Moodle during the main assignment period. These posts will be continually assessed according to a set of criteria that I am developing but based on work of Garrison et al. Each post is graded using one of the four following criteria.

<table>
<thead>
<tr>
<th>Triggering posts</th>
<th>Recognising the problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration posts</td>
<td>Sense of puzzlement</td>
</tr>
<tr>
<td></td>
<td>Divergence within community</td>
</tr>
<tr>
<td></td>
<td>Divergence within single message</td>
</tr>
<tr>
<td></td>
<td>Information exchange</td>
</tr>
<tr>
<td></td>
<td>Suggestion for consideration</td>
</tr>
<tr>
<td></td>
<td>Brainstorming</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Integrating posts</th>
<th>Leaps to conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Convergence among group members</td>
</tr>
<tr>
<td></td>
<td>Convergence within single message</td>
</tr>
<tr>
<td></td>
<td>Connecting ideas – synthesis</td>
</tr>
<tr>
<td></td>
<td>Creating solutions</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Resolution posts</th>
<th>Vicarious application to real world solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Defending solutions</td>
</tr>
</tbody>
</table>

Higher marks are given for Integrating and Resolution type posts and lower for Triggering and Exploration posts. A poor grasp of English will therefore have a negative impact on grades for all group members because of inability to fully understand and respond to the posts of others in the groups.

1.7 Assessment issues

The weighting given to this assignment may vary from course to course and as a result students from different institutions may place higher or lower priority on their involvement. Over the years I have discovered that if collaborating institutions can broadly agree on the weighting for this part of the course then students will contribute more equally to the online discussions and report writing.

I assess my course mainly through this task and with a presentation with focusses on the legal and social issues. I also give marks for individual contributions to class discussions and to use of Moodle (I am interested in exploring the use of wikis, glossaries and so forth which are also available in Moodle). I also allocate some marks for attendance at the presentations in my course.
My module grade breakdown is as follows:

- Collaboration assignment 40%
- Presentation 40%
- Contributions 10%
- Attendance 10%

I award marks in this assignment for both group work and individual contribution. The individual contribution is assessed using the criteria outlined above for assessing individual posts. This means that marks for an individual student can vary within any group but it also means that problems with some working harder than others is addressed. We can discuss this in more detail if/when we agree to collaborate.

1.8 Conclusion
The main constraints are to do with timing and grasp of English and assessment weighting. However if these are not a major problem then success is quite likely. I hope you and your students will be able to collaborate. I have found over the past few years that the student participants thoroughly enjoy the experience, do exceptionally well when they participate and it is an enjoyable experience for lecturers also.

Please let me know if you have any questions about this document and I look forward to hearing from you shortly.

1.9 References
Griffin, Joe & Grodzinsky, F., 2002, Blackboard: A web-based resource in the teaching of a multi-disciplinary/multi-institutional computer ethics course, Proceedings of the 2002 International Symposium on Technology and Society (ISTAS'02), Raleigh NC, USA


1 Appendix 7_3: Grading Individual Contributions

Moodle provides a facility for creating and using scales. Scales are defined as “a way of evaluation a student’s performance”. Once a scale has been created it is assigned to an activity, e.g. a forum.

A scale is defined as an ordered list of values ranging from negative to positive. The following screen shows how to create a scale.

![Scale creation in Moodle](image)

Figure 1 Scale creation in Moodle

The user enters the scale name, the list of values and a description that is available to any other teachers who might wish to include it in their courses.

Once a scale has been created it is assigned to an activity and in my research I assigned the CP scale to the case study discussion forum. This is shown in Figure 2 below.
It is possible to select how the values are aggregated. I wanted to have a count of the occurrence of each value but is also possible, if appropriate, to have averages, sums, minimum and maximum ratings calculated.

I had set up three forums in my course. One I used for providing News items, one as a general forum for discussion on any topic by any student or lecturer. The third forum was specifically for use in the case study assignment discussions.

The Case Study forum was set up to enable groups to have private areas for their discussion. This was done at the request of the students. They preferred to have their own area for working. I also assigned the CP scale to this forum. Each post by a student had a drop down menu as shown in Figure 2 above and reproduced here.

I was easily able to categorise each post using CP framework with this facility. On schedule days each week I read the posts and applied the rating. Students were able to see the rating as shown I had given each post and this acted as formative feedback.
I could also see the ratings of all the students using the grades facility on Moodle. Figure 4 shows a section of the output from this function.

![Grades output](image)

The output from the grades function was in a spreadsheet format and showed the ratings for all students or any subset I was interested in. I could there just examine a particular group or an individual student.

For each student the grade column showed the CP categorisation in which the student had the most posts followed by the total number of rated posts in brackets. It then showed the number of each post in each categorisation with Triggering being the leftmost and Resolution being on the right of
the four numbers. Any student who had not posted was shown with a – in the above and if no posts
had been rated this was shown as 0/0/0/0

Each student could see only their own entry in this spreadsheet.