Chapter Three | Approach and Methods

3.01 Introduction

This chapter outlines the epistemological assumptions, knowledge claims, strategy of enquiry and methods of data collection and analysis undertaken in this research. This research embeds the theories of constructivism and experiential learning into design patterns for the field of e-learning. These two learning theories form the pedagogical philosophy of the design patterns and guide the philosophy of this research.

The research approaches and the methods of analysis undertaken are principally informed by the book *Research Design, Qualitative, Quantitative and Mixed Methods Approaches* (Creswell, 2009). This book was particularly suitable for this research in its treatment of qualitative research processes, as it takes a constructivist approach to research design when using observations of behaviour. In establishing a participatory worldview, the research approach in this thesis involves observations of participants’ behaviour and open-ended questioning (Creswell, 2009, p. 16).

3.02 Research Design

The research involves six stages. This section will describe the research stages in detail. How the research questions map to the activities undertaken during the research is outlined in Table 3-1.
Table 3-1 Matrix of research activities mapped to research questions

<table>
<thead>
<tr>
<th>Research Question</th>
<th>R1 Are pedagogically based design patterns useful for creating e-learning courseware?</th>
<th>R2 What is the methodology for embedding a pedagogical framework incorporating constructivist and experiential learning theories into e-learning design patterns?</th>
<th>R3 Does the method improve the pedagogical quality of design patterns?</th>
<th>R4 Do pedagogically-based design patterns assist e-learning designers to be more aware of pedagogical issues when creating e-learning courseware?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation / Formulation</td>
<td>Development of method to embed pedagogy into patterns (Stage 1) Creation of tool to assist pattern writers to achieve method, the ‘pattern pack’, (Stage 2) Creation of design patterns to include pedagogy (Stage 3)</td>
<td>Determine best design for pedagogy pattern (Stage 4) Identification of standard design pattern and comparative analysis with best design for pedagogy pattern from Stage 3 (Stage 4)</td>
<td>Creation of wireframe drawings, user interface sketches or information architecture based on generic and pedagogically-based patterns (Stage 5)</td>
<td></td>
</tr>
<tr>
<td>Observation / Data collection</td>
<td>Use of ‘pattern pack’ with a set of 8 pattern writers (Stage 3) Data collected: 8 design for pedagogy patterns for an e-learning forum (Stage 3)</td>
<td>Textual structural comparison of best design for pedagogy pattern and standard design pattern (Stage 4)</td>
<td>Data collected: Videotape recordings of ‘think aloud’ Wireframe drawings, user interface sketches or IA of an online forum (Stage 5) Structured interviews after each design session (Stage 5)</td>
<td></td>
</tr>
<tr>
<td>Tools and evaluation</td>
<td>Ranking of patterns using evaluation instrument to determine best design for pedagogy pattern (Stage 4)</td>
<td>Analysis of effectiveness of design making method (Stage 4)</td>
<td>Content analysis and qualitative studies (Stage 6)</td>
<td></td>
</tr>
<tr>
<td>Analysis</td>
<td>Analysis of all results</td>
<td>Analysis of pedagogical quality of design for pedagogy pattern (Stage 4)</td>
<td>Analysis of effectiveness of design assistance (Stage 6)</td>
<td></td>
</tr>
</tbody>
</table>

The analysis of the research data maps onto three different axes of the diagram outlined in Figure 3-1. These three axes represent three different ways to interpret the concept of ‘useful’ design for pedagogy patterns. Axis one describes the usefulness of the pattern writing tool, which supports the creation of a design for pedagogy pattern. Axis two relates to the evaluation of the quality of the design for pedagogy patterns. Axis three considers the value of design for pedagogy patterns on the design process.
When the three axes of evaluation have been completed, the results can be triangulated to provide the answer to the principal research question.

The principal research question is, ‘Are pedagogically-based design patterns useful for creating e-learning courseware?’ In order to answer this research question, this research project includes the following research objectives (RO):

- (RO1) Formulate a method for creating a design for pedagogy pattern
- (RO2) Develop a tool that embodies the method and use this tool with a set of design pattern writers to produce design for pedagogy patterns
- (RO3) Compare the quality of the design for pedagogy patterns
- (RO4) Compare the value of the best design for pedagogy pattern against a standard design pattern for the same e-learning courseware with a set of designers and educators on their design process

Each of these research objectives refers to one of the research questions. The first sub-question (R2) relates to the methodology for embedding a pedagogical framework into design patterns for e-learning. This research question calls for textual research into:

- The theory and practice of design patterns
- Constructivist and experiential learning theories
- Current and best practice in user interface, information architecture and content layout for e-learning

Figure 3-1 Different axes of evaluation illustrate the three research sub-questions.
Chapter 3: Approach and Methods

- Standard design pattern for structural comparisons
- Examples of e-learning courseware

Textual research will be used to create a method for writing design for pedagogy patterns, using grounded theory (Creswell, 2009). The method will be embedded into a tool, which will be used by a set of pattern writers to write design for pedagogy patterns. The creation of the method and the iterative design and evaluation of the value of the tool to pattern writers will make up Research Stages One through Three.

The next sub-question (R3) considers the quality of design for pedagogy patterns compared to a standard design pattern. The design for pedagogy patterns will be assessed using expert evaluation. The highest ranked design for pedagogy pattern will be compared with a standard design pattern to determine the differences between them, with an emphasis on determining improved pedagogical quality.

The final sub-question (R4) considers the value of design for pedagogy patterns to designers and educators. The assessment of their awareness of pedagogy during the design process will be evaluated using a within-subjects laboratory experiment. A set of designers and educators will be asked to create e-learning courseware using a design for pedagogy pattern and a standard pattern. Data collected during the experiment will include designers’ ‘think aloud’ and their wireframe drawings and sketches. Data collected after the experiment will consist of interviews, using structured open-ended questions followed by unstructured comments. Data for this stage will be collected during Research Stage Five and analysed in Research Stage Six. The impact on pedagogical thinking by the participants during the design exercise will be assessed using content analysis. The value of design for pedagogy patterns on the participants’ experience of the design process and of the quality of their design outcome will be based on the data collected.

The six stages of this research and the research questions that they address are summarised in Figure 3-2.

![Figure 3-2 Summary of methods and research instruments relating to research questions. (Chatteur 2010)](image-url)
Each stage of the research cannot proceed until the previous research stage has been completed. In this way, each stage builds upon and adds to the previous research stages in a sequence that forms the entire research project.

### 3.02.01 Epistemological Assumptions and Modes of Enquiry

The main perspectives on knowledge creation that inform this research are those of constructivism and social constructivism. Constructivism colours the research methodology and social constructivism is one of the two main pedagogical theories used to create the design for pedagogy patterns. The other pedagogical theory, experiential learning, shares the same philosophical roots as social constructivism, as it too evolved from the works of Piaget (Kolb, 1984, p. 15). Constructivism demands a qualitative approach to research methods, where the researcher interprets the results, often using open-ended questions where participants can share their views (Creswell, 2009, p. 8). Because of the large number of variables involved in the study of design and design processes, and the need to interpret the phenomenological data (e.g. the experience of the designers whilst using a design for pedagogy pattern), there is a need for a qualitative approach for most of this research project.

The qualitative nature of this research project is also encapsulated in the need to use grounded theory in the textual research to develop the method for creating design for pedagogy patterns. In grounded theory, a researcher approaches their investigation without a preset opinion or notion in mind, rather lets the theory emerge from the data (Glaser & Strauss, 1967; Groat & Wang, 2002, p. 180). A feature of grounded theory is its use of an intensive, open-ended, and iterative process that simultaneously involves data collection, analysis and theory building (Groat & Wang, 2002, p. 181). A grounded approach requires a going back and forth between collecting data, analysis and theory building – the object of study is not necessarily apparent ‘on the first take’ (Groat & Wang, 2002, p. 182).

The use of a grounded approach within a study that employs constructivism implies the use of constructivist grounded theory (Mills, Bonner, & Francis, 2006). Constructivist grounded theory has been called ‘ontologically relativist and epistemologically subjectivist’ where ‘data do not provide a window on reality. Rather, the “discovered” reality arises from the interactive process and its temporal, cultural, and structural contexts’ (Charmaz, 2000, p. 524 in Mills et al., 2006, p. 6). The constructivist grounded approach in this research was used to identify the ‘core category’ or ‘gut sense’ (Mills et al., 2006, p. 6) about the appropriate method for writing design for pedagogy patterns and to iteratively develop the topic (or pattern problem statement) of the design for pedagogy pattern.

Constructivism is not the only worldview used in this research. A postpositivist worldview takes the approach that data can be categorised and measured. However, postpositivism is
not usually applied to qualitative data; it is more commonly applied to a quantitative dataset (Creswell, 2009, pp. 6-7). This research uses a more pragmatic approach. By using a sequential mixed methods approach (Creswell, 2009, p. 211), the research design can employ two different epistemologies. The results from both the quantitative and qualitative methods can then be used to confirm the validity of each. Mixed methods research employs the practices of both quantitative and qualitative research strategies in a single study. The strengths of mixed methods research is that data collected in the different forms reinforces the strengths of each method and allows the researchers to gain greater insights from the combination of both qualitative and quantitative research than by either form alone (Creswell, 2009, p. 203). By using a mixed methods approach, it is possible to use the strengths of the methods and research approaches of both a constructivist and postpositivist worldview in the one field of study.

This mixed methods approach will take place at Research Stage Four, the analysis of the quality of the design for pedagogy patterns. The pattern evaluation instrument collected both quantitative and qualitative data using a concurrent embedded strategy (Figure 3-3), with the emphasis being on the quantitative data.

The quantitative data collected allows the patterns to be ranked so that the best design for pedagogy pattern could be used in the next research stage. The qualitative data in the form of additional comments were used to reinforce the findings from the quantitative data. The two sources of data allowed the integration of the information and the comparison of one set of data with the other (Creswell, 2009, p. 214). In this way it was possible to determine not only the quality of the design for pedagogy pattern but also how successfully the pedagogical framework was embedded in the patterns.

The highest ranked design for pedagogy pattern was also subjected to a textual comparative analysis with a published standard design pattern for a forum. This highlighted the differences in the patterns and identified areas where pedagogy was embedded in the pattern. The two analyses in conjunction with the methodology developed during this
research answer R3. The choice of the standard design pattern will be discussed later in this chapter.

Figure 3-4 Qualitative research methods, Stage 6. (after Creswell, 2009, p. 185)

Data collected for R4 is qualitative in nature and was obtained concurrently. That is, the 'think aloud' data for the content analysis was collected at the same time as the interview data for the subsequent qualitative analysis. Concurrent data collection reduced the amount of time required in the field whilst collecting all of the relevant data for the within-subjects laboratory experiment. The process of data collection, processing and analysis followed the steps shown in Figure 3-4, which illustrates that the emphasis on procedures, types of data and methods of data collection and analysis in the laboratory experiment was on qualitative data, and describes the research process that was undertaken in Research Stage Six.

Subjectivity is embodied in the main research question. The usefulness of a design for pedagogy pattern will vary depending on the designer. Individuals with various levels of design experience may enact the design for pedagogy patterns in a different manner. In examining the ways that designers of varying levels of experience use the design for pedagogy pattern, it will be possible to determine the usefulness of the pattern. This brings into play the worldview of the person or persons performing the evaluation. The data
Analysis for Research Stage Six requires the interpretation of the spoken word, using two methods of interpretation:

- Content analysis
- Interpretive qualitative analysis

Content analysis allows us to measure differences in thinking when designers use the two different patterns, by asking them to 'think aloud' as they design. Concurrent 'think aloud' is a subjective, experiential description of the design process in which people construct an account of their experiences (Creswell, 2009; Krippendorf, 1980).

This research assumes that some internal thoughts of designers undertaking a design process can be captured if they are asked to vocalise or 'think aloud' as they design. A 'think aloud' exercise only captures the utterances that the designers decide to vocalise – they may forget to talk, a level of self-editing or censorship may take place, and some thoughts or decision making may occur too rapidly to be crystallised into speech. Any 'think aloud' captured on video can therefore only be said to be an indication of the internal thoughts of the participant (Krippendorf, 1980).

A study done by Cotton and Gresty (2006) appears to indicate that 'think aloud' does indeed capture the subject's genuine thoughts 'as opposed to simply telling us what they thought we wanted to hear' (Cotton & Gresty, 2006, p. 51). The same study also indicates that some subjects find 'think aloud' easier than others, using the vocalisation as an opportunity to take the observer through a tour of the materials, providing both positive and negative feedback on the research materials provided.

When using content analysis, utterances are classified and coded – organised and placed into categories. Because English is a language in which any one word may have different meanings depending on the context, this classification is subjective. The meanings derived from the words, and the category any one word may fall into, is a subjective interpretation, based on the understanding and worldview of the person or persons doing the interpretation (Creswell, 2009, p. 176). The coding of spoken word data requires purposeful selection of participants (the coders), and requires individuals who have a similar experience, who can interpret meanings in a similar manner.

This research assumes that a rigorous method for coding 'think aloud' data can be determined. Content analysis will be discussed in more detail later in this chapter and in Chapter Seven.
The analysis in Research Stage Six will also use an interpretive constructivist approach (Creswell, 2009, p. 176) in the qualitative analysis of the meanings of structured interviews of the designers performed after the ‘think aloud’ and from data collected during the within-subjects laboratory experiment. The researcher’s experience and view on design practice will necessarily colour the interpretation and reporting on the designer’s processes while creating the e-learning forum. The prior knowledge and worldview of the researcher also influences the findings from the analysis on how the participants derive value from the design for pedagogy patterns. It also informs the method of analysis using data visualisation.

3.03 The Stages

3.03.01 Stage One: Create Method

Research Stage One consists of two parts. The first task was to complete a textual analysis in order to map Alexander’s (1977) pattern language structure to the e-learning domain. Then the use of frameworks in conjunction with design patterns was examined, and Goodyear’s pedagogical framework (2005) was investigated to determine how this could be enacted within the pattern language and in the intra-pattern structure. The structure of the pattern was adapted to include pedagogy. A preliminary method for writing a design for pedagogy pattern was created. The second part of Research Stage One tested this method in a pilot study to determine how to provide background information to the pattern writers.

Part One: The Textual Research

This phase of the research analysed texts from peer-reviewed books, websites, international educational and information technology (IT) journals, and academic papers. The search was conducted through the University of Sydney Library’s collection of online databases, and through an internet search of academic papers.

In generating the method for creating design for pedagogy patterns there were a number of factors that needed to be considered. In Research Stage One, part one it was necessary to:

- Examine the theory and practice of design patterns to establish how to incorporate pedagogy into design patterns, with a focus on creating a design for pedagogy pattern structure
- Create and trial a preliminary method using the design for pedagogy structure
- Use educational theories to drive the interaction design of e-learning courseware
- Develop design principles for e-learning based on these educational theories

The aim here was to produce a repeatable method that created patterns that incorporate pedagogy, not just the creation of a design pattern per se (Chatteur, Carvalho, & Dong, 2008). The textual research aimed to produce/curate a set of example implementations of e-learning
courseware that enacted pedagogy for later use as example solutions as a basis for writing a pattern based on the design for pedagogy pattern structure.

This research stage used an iterative design process, taking a top-down approach. Working from broad issues, such as structure, method, framework, design principles, I trialled the method to narrow down the text analysis to specifics – to determine the pattern problem statement, solution and teaching strategies. Each part of the text search built upon the next, and informed the direction of the subsequent research.

In the next sections the areas covered in this textual research will be discussed.

**Theory and practice of design patterns.** The Alexandrian pattern structure (Alexander *et al.*, 1977) was examined to see if it is able to support both design (i.e. user interface, information architecture and content layout) and pedagogy (i.e. teaching and learning practices) in the context of e-learning. I will establish how to incorporate Goodyear’s pedagogical framework into the Alexandrian pattern structure. Goodyear’s framework (Figure 2-2) uses an overall pedagogical philosophy that drives high level pedagogy (broad approaches, such as collaborative knowledge building), pedagogical strategies and tactics that inform the environmental setting, tasks and organisational forms of the learning (Chapter 2).

In incorporating the pedagogical framework there were criteria that needed to be addressed:

- How to holistically embed Goodyear’s pedagogical framework into the design pattern
- How to match the learning activities (i.e. pedagogical strategies) to the pedagogical philosophy
- How to ensure the resulting courseware (incorporating the learning activities) is used in the manner for which it has been designed

If the Alexandrian pattern structure did not provide an appropriate framework for providing both design solutions and supporting pedagogy, then the structure would need to be adapted.

**Create a method.** After the examination of the Alexandrian design pattern structure, a preliminary method for embedding pedagogy into design patterns was created. This method follows the plan:

- Text search or identification of pattern problem
- Definition of problem
- Text search for solution, teaching strategies and optional case studies
- Write the design for pedagogy pattern in terms of constructivist and experiential learning theories

The text search placed an emphasis on determining a commonly used e-learning application or courseware feature that was to have been chosen using an iterative, grounded approach. This determined the area that could afford treatment with a design for pedagogy pattern. The
general area for treatment by the pattern emerged as a result of this early stage of the textual research, but the actual wording of the pattern topic could not necessarily be determined at that stage. Current examples of e-learning courseware were located and examined so as to narrow down the study’s pattern area.

Trialling this method will be discussed in detail later in this section, and in more detail in Chapters Four and Five. The findings of the trial informed the next part of the textual research.

**Use educational theories to drive the interaction design of e-learning.** In order for pattern writers to incorporate constructivism and experiential learning into the writing of design patterns, they need to first gain an understanding of the two learning theories. A literature search involved examination of peer-reviewed journals and core texts on the two learning theories. Criteria for this examination were:

- Identification of the learning theories’ core concepts
- Identification of pedagogical strategies and tactics which best enact these core ideas in the context of e-learning courseware

Once the main principles were known they were written up into the two primers, one for constructivism and another for experiential learning.

**Develop a set of design principles.** I investigated and examined the latest (i.e. later than the year 2000) peer-reviewed research (in the form of research papers) in the field so as to establish ‘best practice’ and ‘current practice’ in the field of e-learning. By examining peer-reviewed literature it was possible to identify different types of e-learning courseware and associated pedagogical activities. That is, what has been designed and how the design allows pedagogy to take place. This included what sort of pedagogical activities are possible, and whether that type of activity matches that which best promotes constructivism and experiential learning.

Based on the peer-reviewed research, a set of design principles that incorporated the main tenets of the two learning theories was created. These principles matched learning activities (i.e. the pedagogical strategies and associated tactics) to design practice for e-learning. One set of principles was written for each learning theory and placed in the primers.

The pedagogically-based design principles helped the pattern writers choose appropriate pattern solutions when writing the pattern. They provided a set of e-learning activities or general guidelines for the writers so they could choose design features which could incorporate these activities in the pattern solution. By using current and best practice, the resulting design for pedagogy pattern documents were able to provide up-to-date tested solutions.
Part Two: Iterative Design of Method and Development of Pattern Writing Documentation

This textual research complements the literature review and determines one way to create generic design for pedagogy patterns for e-learning, using grounded theory. This first research stage took some of the principles outlined in the textual research and implemented them – it is the distillation of current theories on e-learning into practical application, and as such has a different purpose.

By examining, documenting and refining my own approach to developing design for pedagogy patterns, I began to create a generaliseable method. The textual research, method and documentation was trialled, evaluated, revisited or refined numerous times until the method for creating design for pedagogy patterns for e-learning was proven to be usable and repeatable. The method was trialled in two ways:

- By writing two design for pedagogy patterns myself
- Using a series of pilot studies with pattern writers

These trials helped to formulate the methodology for embedding a pedagogical framework incorporating the two learning theories into a design for pedagogy pattern (R2); and provided preliminary feedback on what made the pattern useful for designers (R1). For my trial and the pilot trials a series of criteria for success were evaluated:

1. The pattern’s problem statement and solution remained focused on design.
2. Clear linkages between design elements and pedagogy
3. Integration of the learning theories into the pattern
4. Ease of use of the method
5. The time taken by the pattern writers

My trial of the method was evaluated to determine whether the first three points on the above list were achievable. The first pilot study was examined for the first four. The second pilot study was evaluated for all five. Success of the method was to be confirmed if feedback indicated that the above could be achieved in a reasonable amount of time. The length of time considered ‘reasonable’ was to be determined from pilot participant feedback.

Design for pedagogy patterns need to incorporate a pedagogical framework. The pedagogical framework informed the types of e-learning solutions that were appropriate, and how these mapped to the overall educational requirements for an online course. Requirements could have involved learning outcomes, tasks, student activity and the learning environment itself (Goodyear, 2005). In order to embed Goodyear’s pedagogical framework into the pattern writing process, the information was provided to the pilot participants in a document explaining the pattern template. In this way the framework (e.g. philosophy, high level
pedagogies, tactics and strategies) could be incorporated into the appropriate area of the pattern.

For the first pilot study the documentation provided to the pilot participants included:

- An empty pattern template
- An explanation of how to use the template in a way that incorporated a pedagogical philosophy
- Two primers: experiential learning and constructivism, which included the pedagogical design principles, (high level pedagogies, tactics and strategies) that support the two theories

The time allocated to each pilot study session and the study location was not controlled. The main purpose of the first pilot study was to evaluate and refine the design for pedagogy pattern writing method.

Pilot Study One involved three participants. The first participant was asked to create a pattern using the method. The resulting pattern was examined for evidence of the use of the two learning theories and to see whether the document successfully made linkages between interface design, information architecture and content layout and pedagogy. Evaluating the method involved non-structured face-to-face interviews incorporating suggestions for improvement of the method. Following the feedback, the method and documentation was refined. In the first pilot study, the pattern problem was not predetermined, and was decided upon by each of the three participants. The writers created the wording of the pattern’s problem statement.

The second participant was videotaped creating the pattern using a ‘think aloud’ technique. The ‘think aloud’ for this pilot study was examined to determine problems with the method, to gather extensive feedback from the participant, and to find areas of improvement. The ‘think aloud’ illuminated any concerns or frustrations on the part of the participant as they undertook the writing task. Feedback was obtained from the second participant, and changes to the method and documentation resulted.

The third participant was given the documents created and modified from the previous participants’ feedback to determine if the changes to the method were effective. The documents were rewritten so that a minimum amount of assistance or supervision was required of the pattern writer.

This stage provided the framework for creating a generic design for pedagogy pattern. The reason the pattern topic was not be predefined for the pilot study was to determine whether the method was beneficial to the pattern writers, giving them the freedom to research and evolve the topic.
3.03.02 Stage Two: Create the Tool

Stage Two involved creating a tool to help writers use the method for a particular pattern problem. From the previous peer-reviewed textual research, it was possible to identify a number of areas that could form the topic for the pattern. That is, the type of e-learning courseware that the design for pedagogy pattern was to explore. This was a narrowing down process; it informed what to look for in the standard pattern used in the comparative laboratory experiment. If this method were to be used in future work, it would inform the creation of the pattern problem statement.

Choosing the Standard Pattern

In order to complete a comparative laboratory experiment, a published standard pattern for e-learning courseware was identified. Finding a comparable published pattern that mapped onto the e-learning domain reduced the scope of available pattern topics for the study. After a literature search, a pattern based on an internet forum was found that fulfilled the criteria of being a published pattern that could be used in the e-learning domain (Schümmer & Lukosch, 2007). This literature search was part of the ongoing textual research which looked for pattern solutions that incorporated experiential learning and constructivism. One reason for the choice of an e-learning forum was that it contained a written record of social interactions between students, thus allowing social constructivism to be examined. E-learning forums allow a community of scholars to become established, where students become teachers, authors, critics and scholars (Dalgarno, 2002).

A forum also contains a record of pedagogical practice. Examination of practice allows constructivist and experiential learning practices to be identified. For example, modelling, coaching, scaffolding, articulation, reflection and exploration are all part of constructivist learning theory (Chee, 2004) and can be identified within a forum. Similarly, an e-learning forum can contain examples of reflective observation and abstract conceptualisation, two key parts of Kolb's learning cycle (Kolb, 1984, p. 42). E-learning forums contain areas within them in which it is possible to see the links between design and pedagogy, i.e. where different types of learning can take place. It was therefore decided to use a forum as the topic for the study.

The emphasis of the design for pedagogy pattern that was developed for comparison with the standard pattern is on a forum’s ability to enhance collaboration and communication between participants of an e-learning course. The design for pedagogy pattern problem was defined by examining a set of peer-reviewed papers on e-learning forums (Berge, 1995; Oren, Moiduser, & Nachmias, 2002; Sargeant et al., 2006). These papers were also provided to the pattern writers in the ‘pattern pack’, as part of the suite of documents outlining current and best practice in e-learning.
The process of defining the pattern problem, and the subsequent task of finding existing forums for stage one and two of the methodology (see Figure 3.1) also brought another issue into focus. Some of the e-learning developers approached were reluctant to make their courseware or applications available, due to copyright, ownership and intellectual property rights issues (IPR). They were reluctant to reveal their applications as they felt that if pattern writers examined them, the format and application ideas would be used without permission by subsequent developers.

There were also privacy issues that prohibited many online e-learning forums that sit behind an online portal from being available. Organisations that use e-learning as a basis were contacted, but did not allow the researcher access to their materials. These included the National College of School Leadership (UK) and Australia’s Open Universities (M.K., 2008; NCSL, 2005). As Australia’s Open Universities is a collaboration between five different universities, each required a separate ethics application in order to participate in this study. Permission was granted, however, from the Open University (UK) and that access was used for this study. There were also a number of online forums for e-learning courses that sit within the public domain that were available for the study.

Developing the Tool

In order to aid the pattern writers, a tool was to be developed to help them in the difficult task of embedding pedagogical theories into a design for pedagogy pattern. The tool was built on the pattern template and primer documents created in Stage One. This involved examining design and pedagogical elements to determine how these were to be enacted in an e-learning forum, using the function-behaviour-structure (FBS) framework (Gero & Kannengiesser, 2004). The FBS structure was used to help identify the design elements and to link them with pedagogical practices.

The tool (the ‘pattern pack’) was iteratively designed and tested with the Pilot Study Two participants to determine if the evaluation factors had been successfully enacted within the patterns they wrote (as in Pilot Study One). The evaluation of the tool was in the form of non-structured interviews with the pilot participants and by examining the resulting patterns. Pilot Study Two was completed when a pilot participant was able to successfully complete the pattern writing exercise using the ‘pattern pack’ within a reasonable amount of time.

The use of the two pedagogical theories in the pattern document would have been apparent if the theories were mentioned by name, or if learning activities were mentioned that mapped directly onto the design principles outlined in the primers. The theories might not have been mentioned overtly, but the pattern document could include issues (e.g. social learning) that the pedagogical theories promoted.
Chapter 3: Approach and Methods

3.03.03 Stage Three: Pattern Writing

Stage Three involved using the ‘pattern pack’ with a set of eight writers. The participants for the pattern writing activity were carefully chosen.

Choosing the Participants

This research required the recruitment of eight participants who were required at research Stage Three to use the method in the ‘pattern pack’ tool to write a design for pedagogy pattern for an e-learning forum. The recruitment of all participants and the conduct of human subject experiments were undertaken under approval by the University of Sydney Human Research Ethics Committee, approval number 10-2007/10073.

The Pattern Writers

Pattern writing is a very complex task. It requires not only competency in writing, but when incorporating pedagogical principles and design into the patterns, expertise or experience in either educational or interaction design or both. Pattern writing needs individuals who are able to assimilate new ideas and to write these up. The choice of participants needed careful consideration to identify and select individuals suitable for the pattern writing task. Without a background in design or design education, this task would be too difficult to complete. The criteria for the selection of the participants were:

- They were either digital media designers or design educators
- Ideally were in possession of (or in the process of getting) a design qualification at post-graduate level
- They were able to write at an advanced level in English

The pattern writers needed to be able to understand the pedagogical theories and the ideas outlined in the peer-reviewed research. As such, it was important that the participants would be familiar with one or more of the following fields:

- Design patterns
- Education or pedagogical theories
- E-learning and internet technologies
- Online forums

The participants for pattern writing were selected from individuals from two tertiary educational facilities – either teachers or current or former research students from the University of Sydney and the Northern Suburbs Institute of Technical and Further Education (NSI TAFE) in Sydney, Australia. Recruitment involved a passive snowballing technique whereby colleagues, friends and associates of colleagues were contacted and invited to participate. In some instances, an announcement was made to the audience of an academic
seminar, who were invited to contact the researcher if they wished to participate in the pattern writing exercise. Participants were emailed or given an explanation of what was required of them, in the form of an Information Sheet and a Participant Consent Form (Appendix 3). Participation was optional and no coercion was imposed. Participants could withdraw from the study at any stage without affecting their relationship with the researcher then or in the future.

**The Pattern Writing Process**

The time that each writer took to write their design for pedagogy pattern was not controlled, as each writer had different demands on their time. The ‘pattern pack’ was given to each pattern writer for a period not exceeding seven days. If the participant was unable to complete the task within a week due to demands on their time, they were asked if they could finalise the task within the next seven days and if not, an alternative participant was chosen. This occurred on three occasions.

Pattern writers were fully briefed on the pattern writing task and use of the ‘pattern pack’, prior to the activity. They were given the ‘pattern pack’, which they could take with them. They were given a week to complete the task in their own time. They were also be given the contact details of the researcher so that any questions or queries about the activity could be answered at any time. Additional coaching or help was available to the pattern writers upon request. This additional assistance was provided on two occasions.

The output from this research stage contained eight different design for pedagogy patterns for an e-learning forum.

**3.03.04 Stage Four: Pattern Evaluation**

Stage Four created and used an assessment instrument that helped to evaluate and rank the eight design for pedagogy patterns. The assessment instrument used both quantitative and qualitative data collection methods and evaluation. The best design for pedagogy pattern from the set of eight was evaluated against a standard design pattern in order to answer Research Question Three.

Two pattern experts ranked the patterns based on the instrument. I acted as one of the experts. I have been researching in the field of design patterns for the past three years. I have published in peer-reviewed literature and have presented papers at international conferences. The other expert was Michael Derntl, who had been researching and publishing in the field of design patterns for the past seven years. He was identified from numerous research papers published in international journals, books and conference proceedings and was asked to participate.
Chapter 3: Approach and Methods

Derntl and I evaluated the eight design for pedagogy pattern documents in order to achieve two outcomes:

- To identify the best pattern
- To evaluate the pedagogical content of the design for pedagogy patterns

This assessment instrument consisted of different types of evaluation:

- Likert scale questions for design for pedagogy patterns in general
- Likert scale questions about this particular forum pattern for e-learning
- Input fields that allowed qualitative comments
- A ranking value (1-8) where 1 was the best pattern and 8 was the worst
- A quality value (1-5) where 5 was excellent, and 1 was poor

There was a set of five variables that determined a pattern’s quality. A design for pedagogy pattern must:

1. Show the relationships between pedagogic strategies associated with the design elements and those linked with the general and abstract ways of thinking about education, including the social and the educational context, teaching practices and the tactics for engaging students.
2. Make the pedagogy explicit, in how it is articulated through image, text and interaction.
3. Link teaching practices with the resultant courseware.
4. Address issues of user interface, information architecture/navigation and content layout.
5. Be well written, communicate clearly and be easy to put into practice. Clearly show how this particular pattern relates to others within the same pattern language.

The evaluation variables and the questions that addressed each variable will be discussed in detail in Chapter Six.

The evaluation of the patterns used a concurrent embedded strategy (Figure 3-3). The primary method of evaluation was quantitative, using the bipolar Likert Scale, with qualitative comments to help reinforce the quantitative data. To make the instrument quantitative, a numeric value was assigned to each response. The questions were phrased in such a way that a ‘strongly disagree’ mapped to a response that indicated lower quality or disapproval. The valuation of the responses ranged from 1 for a ‘strongly disagree’ to 5 for a ‘strongly agree’. Patterns with higher numeric value indicate a better quality pattern.
The first set of Likert scale questions evaluates design for pedagogy patterns in general, that is, issues that should hold true for all patterns developed using the method, not solely for the forum pattern. These questions were structured so that they could be used to evaluate any future design for pedagogy patterns concerning different areas of e-learning courseware. This allows consistency between this research project and any future work.

At the end of each set of Likert scale questions, a field was provided so that additional comments relating to those questions could be made by the evaluators. Comments in these fields were optional.

The next set of Likert scale questions related to the pedagogical quality of the e-learning forum in particular. As e-learning forums allow communication between participants, these questions focused on social interaction and communication. The questions were taken from social constructivist and experiential learning theory.

The experts were asked to separately grade their overall impression of the quality of the design for pedagogy pattern, on a scale of 1 to 5, where 5 was excellent. This question’s aim was to judge the overall quality of the design for pedagogy patterns, not just within the context of the patterns evident in this study, but as an overall evaluation. This aided in the aggregation of the results, but also acted to place the design for pedagogy patterns within the context of design patterns in general.

This was followed by a short questionnaire asking the experts for their opinion about the use of pedagogy in the pattern. This qualitative analysis enriched the quantitative data with background information and opinion. It was captured via a textual input field on an online survey tool. The experts were then asked to rank the pattern, using a numerical value of 1-8, one being the best pattern, and eight being the worst.

Had there been disagreement on the highest ranked pattern, after the data had been correlated, or two patterns emerged with the same top ranking, this would have necessitated further discussion, arbitration and evaluation between the pattern experts until there was an agreement. The data, however, did not require further arbitration.

The highest ranked design for pedagogy pattern was then evaluated qualitatively against a standard design pattern using textual analysis. This comparison determined differences between the standard published pattern and the design for pedagogy pattern. This evaluation, in addition to the assessment instrument results, informed the answer to Research Question One.
3.03.05 Stage Five: The Laboratory Experiment & Data Collection

Stage Five assessed the value of the design for pedagogy pattern against the standard design pattern to pattern users by using a comparative within-subjects laboratory experiment. This section discusses why the different user groups were chosen, the recruitment of the participants and the process of data collection.

Cognitive Productivity and Process: Novice to Expert Designers

To understand the differential in value, three different groups of designers were recruited. The designers were carefully chosen and organised into three distinct groups:

- Novice digital media designers
- Experienced digital media designers
- Digital media design educators with experience in e-learning

These three different user groups were chosen so that differences in the use of the patterns could be anticipated. Recent studies indicate that solving problems in the design domain involves different strategies on the part of designers than other types of problem solving involving novice and expert users.

Because designers manage ill-defined problems, the strategies employed appear to deviate from ‘standard’ problem solving techniques studied in well-defined problem domains. These ‘standard’ techniques are characterised by novices exhibiting a ‘depth first’ strategy, where sub-solutions are explored in depth, whereas experts exhibit a top-down ‘breadth first’ approach. Both expert and novice designers, on the other hand, appear to use similar bottom-up, or ‘working backward’ problem solving strategies. Expert designers exhibit problem decomposition strategies, which novices appear not to possess (Cross, 2004, p. 429).

Cognitively, expert designers are more productive and active in the conceptual design process than novices. In a protocol analysis of a novice and expert architect, Kavakli and Gero (2002) found that the cognitive processes of the expert continually rose during a design experiment, whereas the novice started at a cognitive peak and then declined continuously. The expert also exhibited more structural organisation in their concurrent cognitive actions (Kavakli & Gero, 2002). Experts also appear to integrate visual and technical elements of design and consider them in a parallel way during the design process (Cross, 2004, p. 431). They are able to access different types and amounts of knowledge and are able to use this knowledge more extensively by exploring the implications of that knowledge by re-interpretation. Thus expert knowledge varies in terms of type, amount and pattern of use, but also in terms of interconnectedness when compared to novices. This interconnectedness allows experts to more easily access long term memory (Purcell & Gero, 1998, p. 397).
Novices, on the other hand, exhibit more of an exhaustive search when designing, which could result in their lower productivity (Kavakli & Gero, 2002). Novice designers exhibit a more discovery-led design process, where remote associations can be made available. Experts appear to have control and structure over their cognitive actions and enhanced speed when designing. The enhanced speed they exhibit during the design process also results in higher productivity. This may result in the novice designer creating more novelty, whereas the expert designer displays more expertise (Kavakli & Gero, 2002, p. 40).

The transition from novice to expert designer has been studied and problems arise when novices have a little experience. Senior students can become stuck on this information gathering stage, rather than progressing to solution generation. Successful senior students, in terms of the creativity of their solution, searched for less information and processed it instantly, appearing to build up an image of the problem. Unsuccessful students gathered a lot of information, but this became a substitution for doing any work (Cross, 2004, p. 430). Design students at this level can also become ‘fixated’ on a particular type of design response. This has been found to be true of designers working in an unfamiliar field who are forced to rely on everyday knowledge, rather than knowledge that is specific to their design domain (Purcell & Gero, 1996, p. 380). Designers can also become fixated in the traditional sense when shown examples that represent principles which are characteristic of a knowledge base in the discipline. When shown innovative examples, designers from some fields, such as mechanical engineering, can become fixated on a particular principle. Designers from disciplines that promote a more creative approach, such as industrial design, may become fixed on being innovative and ignore using the principle involved (Purcell & Gero, 1996, p. 381).

Recent graduates new to the design field also exhibit a ‘trial and error’ approach to design, generating one design approach, evaluating it, and then generating another. Expert designers made a preliminary evaluation of their tentative decisions before implementing them and making a final evaluation (Cross, 2004, p. 431). The experts made more integrated design decisions.

The use of design for pedagogy patterns therefore may change as the designers gain experience. As expertise develops, knowledge becomes more structured and more integrated with past experiences. This allows retrieval from memory to occur in larger chunks (Casakin & Goldschmidt, 1999, p. 154). A key competency in the expert is the ability to stand back from the specifics of accumulated examples and form abstract conceptualisations based on their domain expertise. They are able to recognise underlying principles, rather than focusing on only the features of the problem (Cross, 2004, p. 432). An expert user exhibits mastery of
designing (Casakin & Goldschmidt, 1999, p. 174).

Designers may find the patterns more useful than the design educators since designers lack training in pedagogy. The differences in the use of the design for pedagogy patterns were discovered using inductive data analysis in the qualitative evaluation of the 'think aloud', wireframe drawings and sketches and structured interviews in Stage Six. By examining the differences in pattern use by designers of different levels of expertise it was be possible to answer Research Questions One and Three. Discovering how designers with different levels of experience use the patterns helped to determine the assistance afforded by the design for pedagogy patterns. This in turn helped to determine how the patterns aided the designers and educators to be more effective in creating e-learning courseware.

**Recruiting the Laboratory Experiment Subjects**

In order to complete the laboratory experiment it was important that the digital media designers and design educators be familiar with:

- Basic design principles
- User interface design
- Interaction design

The participants were also expected to be fluent in written and spoken English.

The participants for the laboratory experiment were recruited from the NSI TAFE and the University of Sydney using a passive snowballing technique. Recruitment of the participants was as follows.

In the case of participants who were students and/or colleagues of the researcher, an announcement or an invitation to participate was made, and participants were invited to contact the researcher for further information. In some cases, participants were known to colleagues of the researcher who were told about the research project and asked if they wished to participate, which was followed up with the approved invitation email. Participants were also contacted by email. No subsequent contact about the research project was made by the researcher. All participation was voluntary, and withdrawal from the study could occur at any time without penalty. Withdrawal from the research study did not affect their relationship with the researcher either at the time of withdrawal or in the future. If an interest was expressed, each prospective participant was then given details of the study, and a Consent Form (Appendix 4). Each participant signed the Consent Form prior to the commencement of the study.
All participants were carefully chosen, as they had to fulfil the selection criteria. The expertise of the participants was determined by unstructured interviews prior to the commencement of the research activities. Only those participants who fulfilled the above criteria were selected for inclusion in the research.

A novice digital media designer was defined as someone with less than three years full-time industry experience. Experienced digital media designers were those with more than 3 years design or IT experience in a full-time role. Design educators were individuals who taught design and who had experience in either e-learning, interaction development or the use of e-learning forums.

**Data Collection**

The participants performed two design exercises: one using a standard published design pattern for an online forum; one with the highest ranked design for pedagogy pattern. Each design exercise was to be completed in separate sessions, of an hour and a half each. There was a minimum duration of two weeks between each session. This separation of session times allowed the participants time to forget the pattern used in the previous session and the design solution they provided. Several of the participants commented that they did not remember their previous design, so this time separation appeared to be effective.

During the experiments, three sets of data were collected. (Refer also to Table 3-1):

- Videotapes of the ‘think aloud’ exercise
- Structured and unstructured interviews
- Visual representation (wireframe drawings and sketches) created during the exercise

Videotape of ‘think aloud’ was the main method of data collection for the comparative study so that utterances from the two design activities could be transcribed, for use in Stage Six.

Structured and unstructured interviews were used for the qualitative analysis as it was important for the designers to express their own views on the quality of design assistance of the two different patterns. The level of detail required and the use of personal opinion makes this type of data collection essential. This data informed the evaluation of the quality of the design assistance embodied in Research Questions Three and Four.

The visual representations of the forums (wireframe drawings and sketches) were examined in the context of the ‘think aloud’ that was recorded as the designers created the drawings to determine if there was evidence of the use of pedagogical principles being enacted in the e-learning forum design.
3.03.06 Stage Six: Data Analysis

Stage Six was the data analysis stage. Two different analysis methods were used, content analysis of the ‘think aloud’ data and a qualitative analysis of one representative from each of the three different user groups in the comparative within-subjects laboratory experiment.

Content Analysis

Content analysis has been described as one of the most important research techniques in the social sciences (Krippendorff, 2004, p. xiii). It has become a fundamental method in social science and communications research (Krippendorff, 1980, p. 7; Lombard, Snyder-Duch, & Bracken, 2002, p. 587). Content analysis is predominantly a qualitative research method, because it requires the examination of the contents of a particular body of material for the purpose of identifying patterns, themes or biases’ (Leedy & Ormrod, 2005, p. 142). This material can be text, images, audio, video and symbolic matter (Krippendorff, 2004, p. 3). By using the content analysis method, textual data is not divorced from its meaning – it is a way of analysing texts within their context. Originally used mostly in journalism and communications research, content analysis entered the psychological and social science research fields in the 1980s. Today it is used as an alternative to public opinion research, a way of tracking markets, political leanings, emerging ideas and so on. Content analysis allows us to gain insights into human minds (Krippendorff, 2004, p. xiv). By using the content analysis method, a measurable difference in design thinking can be determined when analysing the designers using the two patterns.

Content analysis involves placing words or phrases from a body of text into categories. What these categories are is determined by the nature of the study, by what is being examined. The process of placing the text into categories is called coding. The method by which the data is coded is known as a coding scheme, in which the data (meanings in phrases, sentences/utterances or words) is identified and measured by an analyst (known as a coder). The classification or categorisation of the data is qualitative; it requires interpretation on the part of the person creating the coding scheme.

The data analysis is quantitative, in which the frequency of each code is counted, resulting in a set of numeric values. These values can then be used in descriptive statistical analysis. Even though the data in content analysis is quantitatively analysed, content analysis is considered a qualitative research method (Leedy & Ormrod, 2005, pp. 142-143). Determining the meaning in any communication data can be a very subjective process, as different people bring their own experience and understanding to the data. This can result in very different interpretations of the same data.
This analysis will focus on the language used during the design process to determine if there is a statistically significant difference in the pedagogical utterances of designers when using the two design patterns: the standard design pattern and the design for pedagogy pattern. By determining the difference in pedagogical utterances, it is possible to determine if the design for pedagogy pattern invokes a higher frequency of usage of pedagogically-based phrases. In turn, the more frequent uttering of pedagogical terms is taken as an indication of a heightened awareness of pedagogy during the design process. By determining if pedagogical thinking is used more frequently when using the design for pedagogy pattern, it is possible to partly address Research Question Three. The content analysis of the ‘think aloud’ dataset will provide the primary results from the within-subjects laboratory experiment.

Research Question Three can be further answered in the qualitative analysis of research participants (see below). By combining the frequency of pedagogical utterances with a qualitative analysis of the design process, wireframe drawings, sketches and interviews, it is possible to determine whether the design process is improved. ‘Improved’ in this context means considering and integrating the principles of teaching and learning into the design thinking when the courseware is created.

**Categorising the Data**

The qualitative categorisation used inductive data analysis, where the keywords and categories were built from the bottom-up (Creswell, 2009, p. 175) during the transcription of the ‘think aloud’ data. The keywords were drawn from phrases used in the ‘think aloud’ itself, and from earlier stages of the research. These categories were determined by looking at the different design activities undertaken during the within-subjects laboratory experiment. The use of pedagogy was one of those activities, and some of the codes/keywords for this category were drawn from the research undertaken in Stages One and Two. Keywords could only belong to one category, and if it was impossible to clearly classify a word due to ambiguity, it was removed from the analysis.

These categories were:

- Pedagogy
- Task analysis
- Navigation/Information architecture
- Visual design
- System design

The reference for the categories took the form of a keyword list, which was used during the coding. The keywords were identified in the ‘think aloud’ data, and as the first iteration of the
coding was done, this list was added to. The process of creating the final coding schema will be discussed in more detail in Chapter Seven.

**Inter-Coder Reliability**

Put simply, reliability is whether data can be trusted or not. The data may exhibit a genuine phenomena, or it may be that the findings are spurious, unreliable or a factor of chance. Two coders may disagree on the interpretation of the ‘think aloud’ transcriptions. Coders may get tired, may have their own philosophical agenda or simply overlook important factors in the text. Coders may be replaced, or different coders may work on different parts of a large project. Categories may be unclear; a coder may misinterpret the instructions or misread a keyword. All of these factors may contribute to making a set of data unreliable (Krippendorf, 1980).

In order to determine whether any analysis of the ‘think aloud’ experiments with the designers was rigorous, the reliability of the coding scheme had to be tested. Reliability assessments serve as a safeguard against contamination of data by factors outside the aims of the experiment. Reliability determines the extent to which research design and the resultant data differs from chance, and helps to eliminate idiosyncrasies of individual analysts (Krippendorf, 1980, p. 129).

One way of determining if an interpretation or coding of data is reliable is to compare two different people’s coding of the same data. This is called inter-coder reliability. Inter-coder reliability is the widely used term for the extent in which independent coders evaluate a characteristic of a message or artefact and reach the same conclusion’ (Lombard et al., 2002, p. 589). Two coders categorise the same set of data then use ‘these categorizations to calculate a numerical index of the extent of agreement between or among coders’ (Lombard et al., 2002, p. 590).

Once a keyword list is generated, an inter-coder reliability check is done on a portion of the data. This process uses two people (coders) to determine if there is agreement on the categorisation of the phrases based on the prescribed keyword list. For the content analysis, I was one of the coders. Inter-coder reliability allows ambiguous phrases and utterances either to be placed into particular categories – or eliminated from the analysis altogether. When there was disagreement, then I (Coder A) determined which category a phrase fell into, or decided to eliminate it from the analysis.

In order to see whether the agreement between the coders was better than chance I used Krippendorff’s alpha (1980, p. 134). According to Krippendorff, his alpha (α) represents the
amount of agreement by the extent to which the observed concurrences resemble the table
with maximum agreement over that which is merely chance. This is expressed in the formula:

\[
\text{Observed concurrences} = \alpha(\text{maximum agreement}) + (1- \alpha)(\text{chance agreement}).
\]

Krippendorff developed this coefficient for calculating inter-coder reliability specifically for
content analysis, but its use has since broadened to include any instance where ‘two or more
methods of processing data are applied to the same set of objects, units of analysis, or items
and the question is how much they agree’ (Krippendorf, 2007, p. 1). Krippendorff’s technique
of inter-coder reliability allows the direct comparison of each chunk of data, and then
compares the results against chance. When calculating Krippendorff’s alpha a value of less
than 0.8 above chance is not seen to be completely reliable (2007, p. 147).

Once the reliability of the codes verified that particular words belonged in a particular
category, the remaining transcripts for all 18 design sessions were coded. As part of the
process, it was necessary for the coder to undertake a fatigue test to further check reliability.
Once the entire set of transcriptions of the ‘think aloud’ was coded, a second pass was done so
that keywords that were generated late in the coding were able to be incorporated in the
earlier passes, and to correct any errors.

Once the words or phrases for each sentence/utterance had been categorised, there was a
count of the categories. Once the data was counted, the two sets of data, the content analysis
of the standard pattern and the content analysis of the design for pedagogy pattern, were
evaluated for statistical significance using a paired samples t-test and a standard level of
significance \( \alpha = 0.05 \).

A pair samples t-test is used to determine whether there is a statistically significant
difference between two sets of data. If a value of 0.05 or less is returned using this analysis,
data is deemed to be statistically significant.

**Qualitative Analysis**

The secondary method of analysis was qualitative, including an in-depth examination of data
collected from each of the user groups. The qualitative analysis examined both the ‘think
aloud’ data, the set of structured and unstructured interviews, wireframe drawings and
design sketches. This analysis interpreted the themes found in the data and described in
detail the comments, meanings and understandings of the designers as they undertook the
designs, and their reflections on the task. This analysis was used to reinforce the findings of
the content analysis, and to answer Research Question Four.
Chapter 3: Approach and Methods

The qualitative analysis drew on participants from the three different groups – only one participant per user group was chosen for the analysis; those individuals whose ‘think aloud’ results best reflected the overall results shown in the content analysis. This analysis determined if the value derived from the use of the design for pedagogy patterns differed depending on the different user groups, and whether the patterns were to be used in a different way depending on the experience of the designer. This was to determine the quality of the assistance given to designers from different user groups.

Design Sketches and Methodology

The paper prototypes and sketches were examined in the context of the ‘think aloud’ data, with an emphasis on the designer’s methodology. Differences between the sketches by novice and experienced designers and design educators were examined and highlighted. By examining the form and nature of the e-learning forum design sketches, it was possible to determine whether deeper pedagogical thinking informed the design methodology. ‘Deeper’ pedagogical thinking may be embodied in the overall approach to the design of the e-learning forum, or analysis on the part of the designer/design educator as to how to best integrate pedagogy into the design.

The complex nature of ill-defined ‘wicked’ problems requires that designers draw on prior knowledge and refer to what is to be designed in order to create a single, realisable artefact – the thing that is being designed. ‘On the one hand the design process has to result in a sufficiently specified and coherent physical object. Conversely, statements about what is to be designed and the knowledge that is relevant to it take the form of abstract, conceptual, propositional knowledge which is without specific physical referents’ (Purcell & Gero, 1998, p. 391). Sketching is believed to help this process. Long term memory contains examples of precedent information. Sketching allows the designer to explore this information in the context of a particular design problem in a way that would be difficult to do working entirely from the ‘mind’s eye’. Sketches externalise the content of an image and work as an external memory prompt. As sketches are relatively unconstrained and ambiguous, they can also allow new ways of looking at the internal image. This allows for evaluation and re-interpretation of the sketch in the context of other examples of prior knowledge, and this is believed to result in novelty and innovation. Thus, sketches are often the starting point of design, and allow new forms to emerge in the further development of the design’s visual form (Purcell & Gero, 1998, p. 392). By freeing working memory, drawing allows the access of physical forms of knowledge to move from conceptual to the physical – allowing the exploration of the implications of this knowledge and establishing the conditions for re-interpretation (Purcell & Gero, 1998, p. 419).
Designing moves from a preliminary stage through refinement to a more detailed design. This involves moving from unstructured sketches to more precise drawn representations. Two types of transformations have been seen in design, lateral transformations, where there is movement from one idea to a different idea and vertical transformations, where drawings are given more detailed treatment and refinement. Sketching has been found to be particularly useful in the preliminary stages of design and actually facilitates lateral transformations. This is seen to be an essential phase of the design process (Purcell & Gero, 1998, pp. 394-395).

The sketches and ‘think aloud’ were examined to determine whether pedagogical thinking informed the lateral transformation stage, and allowed pedagogy to be embedded in the multiple representations of the early designs. This may be embodied in the creation of areas where pedagogical activities could take place, the design and use of interface metaphors and the use of design elements, to name but a few.

**Data Visualisations**

One of the problems with using large sets of textual data is that it creates cognitive overload: it can become difficult to see themes and patterns within the data. One way to help identify themes and relationships is to use data visualisation techniques. I used methods of data visualisation to examine the content of the ‘think aloud’ using four of the five evaluation variables used in Stage Four.

To help clarify pedagogical thinking embodied in the overall design approach, I used a ‘Word Cloud’ a data visualisation method that identifies words from a body of text in a frequency count (IBM Corp, 2011). The keywords were colour coded to match the categories in the content analysis.

If designers considered pedagogical issues more frequently, the linkages between design and pedagogy should become more integrated into the e-learning forum design. There should be a correlation between an increase in frequency of pedagogical utterances and design utterances. To help illustrate relationships between design elements and pedagogy, the ‘think aloud’ data was analysed and placed in what I have called a ‘Phrase Wheel’. This is a data visualisation that has been adapted from the ‘Friend Wheel’ application in Facebook (Fletcher, 2011). Instead of displaying relationships between friends, I displayed intra-utterance linear relationships between keywords. This visualisation also displays the richness of the ‘think aloud’ in the number of keywords displayed.

To illustrate the relationships between teaching practices and resultant courseware, I used a data visualisation tool called ‘Phrase Net’ (IBM Corp, 2011). This tool shows the relationships
between different words in a text, using simple pattern matching. The keywords were again colour coded by hand to match the colours used in the content analysis.

In the structured interviews, the participants were asked about how their applications helped students to learn, their planning process, courseware navigation and which elements of the design for pedagogy patterns influenced their forum design. They were also asked about how easy each design pattern was to apply to the design exercise. Unstructured questions asked the participants to comment on the differences between the two design patterns, and what features they preferred. They were also asked to provide insights into designing using patterns, and any additional comments. These comments were used throughout the qualitative analysis to reinforce the findings from the ‘think aloud’ data, and to illustrate key concepts outlined in the visualisations, and sketches.

Figure 3-5 outlines in detail the proposed method for this research. The grey text summarises the research stages, complementing Figure 3.1. The blue boxes provide a detailed breakdown
of the research activities. The red text identifies the modes of enquiry, indicating whether each research activity is qualitative or quantitative in nature. Capitalisation indicates a weight or priority on the quantitative or qualitative data, analysis and interpretation of the study. QUAN or QUAL stand for quantitative or qualitative, respectively. These use the same number of letters to emphasise equality between the different forms of data (Creswell, 2009, p. 210). The green text and arrows identifies what is being measured, relating to the research questions.


