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Supporting the use of learning objects in the K-12 environment

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Supporting the use of Learning Objects in the K-12 Environment

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from

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by

Wayne Grant Cotton
BEd, MEd, MCompStud.

Faculty of Education
2008

DECLARATION

I, Wayne Cotton, declare that this thesis is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Signed:

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I dedicate this work to my father, Graeme William Cotton (1947-1984) and grandparents Olwyn (1923-2004) and Bill Cotton (1924 – 2007) who between them taught me to believe in myself, and to strive for success.

ABSTRACT

In recent years there has been an international agenda to make electronic resources, in the form of learning objects, freely available to teachers and students via on-line databases or repositories. To date, much of the work on these resources has focused on the development of learning objects and the technical aspects of the storage and retrieval processes. Less attention has been paid to the way the learning objects are disseminated and how teachers incorporate the objects into teaching and learning activities. Several researchers (Bennett, Lockyer, & Agostinho, 2004; Hand et al., 2004; Kang, Lim, & Kim, 2003; Koper, 2001b; Laurillard & McAndrew, 2003; Lukasiak et al., 2004; Wiley, 2003) suggest that using generic pedagogical frameworks, known as learning designs, may support teachers who wish to make use of these learning objects. This research study sought out to investigate these claims by designing, developing and evaluating a support system to aid K-12 teachers as they attempt to incorporate learning objects into learning designs.

The theories underlying this support system approach are linked to Vygotsky's (1978) concept of the zone of proximal development and the notion of scaffolding to assist a learners in making progress on tasks that would otherwise be out of their reach (Davis & Linn, 2000; Edelson, Gordin, & Pea, 1999; Quintana, Eng, Carra, Wu, & Soloway, 1999; Reiser, 2002). Using these ideas as a base it was theorised that a cognitive tool in the form of an Electronic Performance Support System (EPSS) could provide the necessary scaffolding to aid teachers through the process of integrating learning objects within pedagogically effective frameworks (i.e., learning designs). The specific learning design used in this study was a WebQuest. This framework was selected because WebQuests are widely known within the K-12 community (Dodge, 1995) and because WebQuests require the use of online resources (i.e., learning objects).

To investigate the integration of learning objects within a learning design, a research approach that could encompass the design, development and evaluative nature of the study was needed. One such approach that has been proven to solve similar broad based, complex, real world problems, while at the same time maintaining a commitment

to theory construction and explanation, is Reeves' development research model (Reeves, 2000; Reeves, Herrington, & Oliver, 2004).

Using the development research procedures outlined by Reeves, this study initially involved a needs analysis to identify the issues that K-12 teachers faced when they attempted to incorporate learning objects within a specific learning design. Considering the findings from the needs analysis with current peer reviewed literature, a series of design principles were generated. These principles were then used to inform the design, development and testing of a web-based EPSS.

The findings of the study suggest that when K-12 teachers attempt to incorporate learning objects within a learning design they face issues in four main areas: 1) limitations in their own technological competency when developing WebQuests; 2) issues relating to how teachers manage the time available to create WebQuests; 3) difficulties in searching for and identifying appropriate learning objects; and 4) maintaining the pedagogical quality within the learning designs.

The web-based EPSS developed in this study addressed these issues by supporting the teachers as they incorporated learning designs into their teaching and learning experiences. The EPSS accomplished this by combining specific information, guidance, online tutorials, and a range of pedagogically effective learning design taxonomies into an all encompassing support structure. The study revealed that there are still more opportunities to develop the support system further, particular in relation to managing the time taken to develop WebQuests and to maintaining the pedagogical quality of the teaching and learning experience.

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Introduction

Background to the Study

There is a plethora of policies, programs and research concerned with the design, development and installation of computer-based technologies for use within educational settings to improve teaching and learning outcomes. As a consequence governments around the world have spent, and are continuing to spend, considerable amounts of money connecting their educational institutions to the Internet. For example, in Australia in 2004 the State Government of New South Wales (NSW) allocated 700 million dollars to do just this as they believed that the Internet, as a tool for learning, has become a critical link in the education of their students (NSW Legislative Assembly Hansard, 2004).

A subsequent phenomenon to this trend in educational technology growth has been in the expansion of educational resources, with one of the more recent areas of focus being the development of learning objects. Learning objects are any digital resource that can be used to support learning (Wiley, 2000). Basic examples include educational videos, pictures or web sites; while more advanced examples may include in-depth interactive applications. Whilst learning objects have been around in one form or another for several decades (Wiley, 2001), only in the last ten years has there been a worldwide focus to develop reusable learning objects specifically for use in schools and make them available to teachers via on-line databases or repositories (Friesen, Roberts, & Fisher, 2002; Laurillard & McAndrew, 2003; Suthers, 2001).

The state and territory governments of Australia were among the first in the world to focus on the large scale development of learning objects. In 2001, these governments committed a combined investment of $68.2 million over the five-year period from 2001-2006, to develop learning objects through *The Learning Federation Schools On-line Curriculum Content Initiative*. This initiative aimed to create Kindergarten to Year 10 (K-10) on-line curriculum content and the infrastructure for procurement, storage, and distribution of learning objects (The Learning Federation, 2001).

In 2005, the Ministerial Council on Education Employment, Training, and Youth Affairs (MCEETYA) reported that *The Learning Federation Schools On-line Curriculum Content Initiative* had created over 500 high quality, globally recognised learning objects and a review was commissioned to look at the success of the programme. This in-depth field review (Freebody, 2005) found that the content developed by the initiative could motivate, engage and enhance the educational experience of students. Based on this review the state and territory governments of Australia agreed to continue with the initiative and committed an extra $58million to extend the project to the year 2009. A major aim of this continued investment was the development of a further 4000 learning objects for use in Australian schools (MCEETYA, 2005).

Statement of the Problem

Despite this increase in funding, there is a growing body of evidence indicating that the actual uptake of learning objects by Kindergarten to Year 12 (K-12) teachers is still in its infancy (Gunn, Woodgate, & O'Grady, 2005; Hand et al., 2004; L. Johnson, 2003; McCormick, Scrimshaw, Li, & Clifford, 2004; Taylor, Slay, & Kurzel, 2007). This literature suggests that teachers are not taking full advantage of the new range of resources that are being made available. To add to the problem there has been an uneven focus on the work conducted on learning objects, with much of the interest concentrating on the development of the learning objects and on the technical aspects of the storage and retrieval processes (Bannan-Ritland, Dabbagh, & Murphy, 2002). Conversely, little attention has been paid to the way learning objects are disseminated and how teachers actually use learning objects in their teaching. Wiley (2002) argued that if this deficiency is not addressed in the near future "…we will find ourselves with digital libraries full of easy-to-find learning objects we don't know how to use" (p. 2). To avoid this happening, and to ensure that this vast investment in learning object development is effectively used, it is imperative to investigate ways that teachers can implement this technology into their teaching (Bratina, Hayes, & Blumsack, 2002; Porter, Garet, Desimone, Yoon, & Birman, 2000). This study attempts to address the issues associated with how teachers use learning objects.

A Learning Design Approach to the Problem

One idea that has been suggested as a potential approach to support teachers, as they attempt to utilize learning objects, is by using generic frameworks which are based on effective pedagogical strategies (Laurillard & McAndrew, 2003; Wiley, 2003). Various frameworks that have been explored in the educational technology research arena include the IMS Learning Design (IMS Global Learning Consortium, 2003), Patterns (Goodyear et al., 2004), the Learning Design Visual Sequence (The Learning Design Project, 2003) and the Learning Activity Management System (The LAMS Foundation, 2006). All of these frameworks, or learning designs, assist teachers as they create learning experiences by providing a defined structure and pedagogy to link together teaching resources and activities. While this has been theorised as an appropriate approach there is a gap in the educational research associated with learning designs. This gap relates to the disproportional amount of research conducted in tertiary settings, when compared to the research conducted on learning designs in the K-12 setting. A challenge to conducting research in this setting is finding a relevant framework for the K-12 environment. There is however one type of pedagogical framework that has been used and tested in K-12 settings. This type of learning design is known as a WebQuest.

A WebQuest is "…an inquiry-oriented activity in which some or all of the information that learners interact with comes from resources on the internet" (Dodge, 1995 , p. 1). Typically, a WebQuest will present students with a challenging task or a problem which can either be simple, short-term and direct (e.g., writing a diary entry imagining you are a knight in the Middle Ages about to go on a crusade), or more complex and long-term (e.g., planning a four week holiday overseas in a targeted culture). Students complete these tasks or problems by working through the WebQuest framework. The WebQuest framework is clearly structured into specific attributes; an introduction (why do this activity), tasks (what is supposed to be accomplished), a process (how to go about it), an evaluation (how students will be assessed) and a concluding (closure) section. A benefit of the WebQuest framework is that WebQuests are created and presented using Hypertext Markup Language (HTML). This enables WebQuests to be stored electronically and delivered via the Internet, thus allowing multiple users to view a WebQuest at the same time. Another benefit is that the framework can aid teachers as they develop WebQuests by providing a predefined pedagogical structure.

Scaffolding with Cognitive Tools

This study set out to explore the notion that a support system can be designed and developed to assist K-12 teachers as they work through the process of incorporating resources (i.e., learning objects) into predefined pedagogical frameworks (i.e., learning designs). This notion of providing support, or scaffolding, traditionally has referred to the process by which a teacher or more knowledgeable peer assists a learner, so the learner can solve problems that would otherwise be out of reach. However, with the recent growth in information and communications technology this traditional view of scaffolding is evolving, with researchers suggesting that scaffolding can now refer to any form of tool, not just a teacher or a peer, that can assist the learner in making progress (Davis & Linn, 2000; Edelson et al., 1999; Guzdial & Kehoe, 1998; Quintana et al., 1999; Reiser et al., 2001). Scaffolding in this sense, is closely related to Vygotsky's theory of the zone of proximal development, which characterises the region between what the learner could accomplish alone and what he or she could accomplish with assistance (Vygotsky, 1978). This link is an important aspect in this study as it can now be theorised that the WebQuest framework can be used as a pedagogical scaffold to support teachers, who have limited experience in using technology for teaching and learning, particularly learning objects.

The type of scaffolding proposed and developed in this study can be described as a cognitive tool. Cognitive tools are aids that enhance users' cognitive ability while solving difficult tasks (Jonassen & Reeves, 1996). A cognitive tool approach was adopted because cognitive tools have the ability to support and guide teachers whilst at the same time extending the thinking processes of the teachers, therefore enabling teachers to learn skills and construct new knowledge rather than just reproducing it (Derry & Lajoie, 1993). A specific type of cognitive tool that has been used and tested in a variety of settings, including education, is an Electronic Performance Support System (EPSS). An EPSS "…provides the user with information, guidance, and learning experiences wherever and whenever a user needs it" (Desrosiers & Harmon, 1996, p. 1). Thus, the cognitive tool that incorporates learning designs is intended to provide teachers with a scaffold for both the process and pedagogy of creating WebQuests that make use of learning objects.

Purposes of the Study

The main purposes of the study are:

1. To develop an understanding of the issues and problems that teachers encounter when they combine learning objects with learning designs.
2. To design, develop and test a system that supports teachers as they combine learning objects with learning designs.
3. To construct a set of design principles that can assist future researchers and instructional designers as they develop support systems for teachers.

Significance of the Study

The significance of this study lies in identifying the issues that teachers face as they attempt to design learning experiences for their students that integrate the use of learning objects. This will aid in conceptualising the pedagogically sound use of technology, by giving an insight into how K-12 teachers use learning objects as they create on-line learning experiences.

The findings of this study will aim to provide a deeper understanding of how cognitive tools can be used to assist teachers as they incorporate computer based technology into their lessons. The findings may also provide the basis for the development of future support systems which scaffold the process and pedagogy needed for incorporating learning objects within learning designs.

In summary, the findings of the study will aim to enrich the growing body of literature concerning the pedagogical use of learning objects in the K-12 environment.

Research Questions

The main focus of the research was to address the following three questions:

1. *What are the issues that teachers face as they combine learning objects with learning designs?*
2. *What design principles guide the development of systems and supports which assist teachers as they combine learning objects with learning designs?*

3. *How do systems and supports address the issues teachers face as they combine learning objects with learning designs?*

Assumptions

Two assumptions were made during the course of the research study. Firstly it was assumed that the teachers would participate in the study, and thus provide the necessary data for this research project. Secondly, it was assumed that the teachers who volunteered to participate in the research would have difficulties as they attempted to combine learning objects with learning designs.

Limitations

The study was limited to the participants who were primary or secondary school teachers in the geographical area of the Illawarra, NSW, Australia. The design principles generated by the study may be applicable to other contexts, and may support and extend the work of previous researchers in the field, but specific findings may be unique to the population studied.

The role of the researcher in this study involved observing, interacting and interviewing participants and analysing data. This raises issues of subjectivity in the data collection and interpretation, in relation to the evidence collected and the conclusions drawn. It was acknowledged that care needed to be taken to avoid bias in this process. To help verify the authenticity of audio transcripts and to substantiate the interpretation of the data the support of a research assistant was engaged to review the coding protocol. The assistant had expertise in both research and teaching in the field of Information and Communication Technology in education.

Overview of the Study

The research approach selected for this study was based on the development research model proposed by Reeves (2000). This model was selected because it provided a practical and theoretical approach to solving complex educational problems, while maintaining rigour due to its commitment to theory construction and explanation (Reeves et al., 2004). The cyclic nature of this model required this study to be conducted in six distinct stages:

Stage 1

The first stage of the research involved an initial needs analysis. The purpose of this was to identify the issues practitioners (i.e., K-12 teachers) face when they attempt to create a meaningful educational experience for their students by combining learning objects with learning designs. Data for the needs analysis was gathered during and subsequent to a series of four 2-hour workshop sessions, in which participants created WebQuests (i.e., learning designs) that incorporated electronic resources (i.e., learning objects). The analysed data was then used to construct a series of design principles with the purpose of guiding the development of the prototype EPSS in the following stage.

Stage 2

Stage 2 involved the development of a prototype EPSS to support the teachers as they tried to combine learning objects with learning designs. The underlying structure of the prototype was based on the guidelines for developing EPSS, found through a review of the literature, while the specific content of the prototype was based on the design principles derived from Stage 1.

Stage 3

The third stage of the research had three foci. It involved evaluating and testing the prototype EPSS, continuing the needs analysis, and refining the design principles. The data for this stage was gathered during and after a second series of four 2-hour workshop sessions in which a new set of participants created WebQuests, (i.e., learning designs) incorporating electronic resources, (i.e., learning objects), using the prototype EPSS for support.

Stage 4

Stage 4 of the research process entailed the design and development of a web-based EPSS. The structure and content of the web-based system was based on an analysis of all the data leading up to this stage. The design and development of the web-based prototype also involved expert evaluation, which led to subsequent modifications.

Stage 5

The penultimate stage of the research involved evaluating and testing the web-based EPSS with a final cohort of teachers, who attempted to combine learning objects with learning designs, by creating a WebQuest, within a one day 8-hour workshop setting.

Stage 6

The sixth and final stage of the research involved the refinement and continued development of the series of design principles for use by future researchers and developers.

Structure of the Thesis

The development research activities and findings of the study are presented in the subsequent chapters. In *Chapter 2* a synthesis of the literature reviewed is provided to form a theoretical and practical basis for the study.

In *Chapter 3* an overview of the development research approach, which was utilized in this study, is presented. In addition to a general discussion of the notion of development research an outline of the specific procedures used in this study is given.

Chapter 4 presents the analysis of data relating to the research questions. It begins with a broad overview of the participants and is followed by a structured description of the six stages of the research project. The chapter concludes with a series of design principles that may be helpful for future designers and researchers as they develop systems that support teachers as they try to combine learning objects with learning designs.

Chapter 5 summarises the research, discusses the major outputs of the study and presents issues that might be elaborated on through further investigation. It also concludes the thesis.

Literature Review

Introduction

This chapter presents a synthesis of the literature that was reviewed to form the theoretical and practical foundation for this study. The review is divided into three main focus areas. The first area looks at the broad nature of learning objects and their role in school education. The second area examines the characteristics of learning designs and how they are utilised to support teaching and learning, before narrowing to one specific type of learning design framework, a WebQuest. The third and final section of the literature review looks at the concept of scaffolding as a means to supporting teachers as they try to combine learning objects with learning designs. The specific type of scaffolding structure reviewed is a cognitive tool in the form of an Electronic Performance Support System.

Learning Objects

The idea of using reusable digital resources in instruction is not new. In fact, the first major theoretical work on the idea was done by David Merrill and his colleagues when they developed the Component Display Theory (CDT) (1983). This theory was a significant contribution to the field of instructional technology as it represented one of the first attempts at separating instructional strategy from instructional content. CDT classifies learning along two dimensions: content (facts, concepts, procedures and principles) and performance (remembering, using and generalities). The theory specifies that designers can effectively develop learning strategies by combining individual aspects of these two dimensions.

Merrill continued working on this theory and the CDT evolved over the next two decades. In the early 1990s, Merrill developed the Instructional Transaction Theory (ITT) (Merrill & ID2 Research Group, 1993). ITT involved the concept of using small self-contained units of information or instruction, known as knowledge objects. Merrill explored the possibility of manipulating these knowledge objects using algorithms, or “transactions” as Merrill called them, to represent different instructional strategies. It was believed that by building appropriate transactions he could automate certain steps of the instructional process and therefore increase efficiency (Merrill, 1999). Merrill and Thompson (1999) tested this theory when they aided in the development of the IDXelerator™, an authoring system implementing the notion of learner centred instruction. They found that the use of knowledge objects and transactions increases authoring efficiency by at least 50%. They also found that the use of knowledge objects increases the effectiveness of the instruction by using scientifically verified instructional strategies consistent with instructional outcomes.

Since then numerous researchers, instructional designers and educational and technology-related organisations have looked into this notion of separating instructional strategy from instructional content. A result of this has been a wide collection of terms describing similar components of instruction. This terminology has included:

- *Asset* (Wiley, 2000)
- *Component* (Ip, Canale, Fritze, & Ji, 1997; Koutlis, Roschelle, & Reppening, 1999; Quinn & Hobbs, 2000; Roschelle et al., 1999)
- *Content Object* (Advanced Distributed Learning, 2005; OASIS, 2003; Shabajee, 2002; Slosser, 2001)
- *Educational Object* (Friesen, 2001)
- *Information Object* (Epsilon Learning Systems, 2003; Wieseler, 1999; Wiley, 1999)
- *Learning Resource* (IMS Global Learning Consortium, 2000; Koper, 2003; Papatheodorou, Vassiliou, & Simon, 2002; Paquette & Rosca, 2002)
- *Media Object* (Advanced Distributed Learning, 2001; Shabajee, 2002)
- *Raw Media Element* (CanCore, 2003; Duval & Hodgins, 2004)
- *Reusable Information Object* (Cisco Systems, 1999; Wieseler, 1999)
- *Reusable Learning Object* (Barritt & Lewis, 2002; Cisco Systems, 2001)
- *Unit of Study* (Koper, 2001b)

McGreal (2004b) examined these various terms and determined that although they are similar, in that they all describe components of instruction, four general types of meaning can be discerned:

1. Objects that, according to their definition, could include anything;
2. Objects that could be anything digital;
3. Digital objects that have been designed with an ostensible learning purpose or outcome; and,
4. Other objects that are specific to a single approach for an individual organisation, like the *units of study* (Koper, 2001b), which are designed based on a specific structure, meaning that they will only work on a specific system.

McGreal (2004b) then categorised the various terminology according to these four general types. An overview of this process, ranging from the general to the specific is outlines below in Table 2-1.

Table 2-1 Various terminology used to describe components of instruction as defined by McGreal (2004b)

Please see print copy for Table 2.1

The variety of the terminology shown in the table above has led to a great deal of confusion, with people tending to use the term ‘learning objects’ to describe the wide variety of instructional components. While it is difficult to pin down exactly who coined the term “learning objects”, credit is given to Wayne Hodgins, who in 1994 called a Computer Education Management Association working group "Learning Architectures and Learning Objects" (Wiley, 2000). The popularity and extensive usage of this term across a variety of organisations and researchers since then, has made clarity extremely difficult and for this study a clearer focus on the terminology was needed.

Learning Object – A definition

At this stage there is no commonly accepted definition of a learning object (McGreal, 2004a). The most prevalent definition comes from the Learning Technology Standards Committee (LTSC) of the Institute of Electrical and Electronics Engineers (IEEE). Their Learning Object Metadata (LOM) standard contains the following definition of a learning object: "…any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning" (Institute of Electrical and Electronics Engineers Inc, 2002). However, it has been suggested that this definition is too broad on the grounds that it can be interpreted as the universal set of all things, not necessarily just things related to learning (Wiley, 2000) and current authors and organisations are providing their own working definitions and terms (Alberta Learning, 2002; Anderson, 2003; Cisco Systems, 2001; Doorten, Giesbers, Janssen, Daniels, & Koper, 2004; Downes, 2003; Friesen, 2001; Koper, 2001b, 2003; Mortimer, 2002; Polsani, 2003; Quinn & Hobbs, 2000; Rehak & Mason, 2003; Sosteric & Hesemeier, 2002; Wieseler, 1999). All of these different definitions that surround the topic have led to more confusion. One researcher's description that stands out and appears to grasp the idea of learning objects in a concise yet homogeneous way. David Wiley (2000) states that a learning object is "…any digital resource that can be reused to support learning" (p.7). This direct, yet all encompassing description allows for a wide variety of resources to be labelled as learning objects, while at the same time excludes those items that would not be useful in this study, for example; non-digital resources as most of these can only be used by one person at a time. It is for this reason that this study will adopt Wiley's definition.

According to Wiley's (2000) definition, in order for something to be classified as a learning object it must have three distinct characteristics. It must be digital, it must be reusable, and it must support learning.

Learning Objects must be Digital

Wiley's (2000) definition states that learning objects must be digital, that is, they must be able to be stored on a computer and therefore be able to be delivered across a computer network. Being transferable across a network enables many users to search for and use the same learning object at the same time. This is an important attribute of learning objects, especially when one considers the current global drive to connect schools to the Internet (Department for Education and Skills, 2003a; National Task Force on Information Technology and Software Development, 1998; New South Wales Legislative Assembly Hansard, 2004; United States of America Department of Education, 2002).

Being digital also allows for learning objects to be associated with descriptive metadata tags. These information tags can either be attached to the object or stored external from the object. These tags range from basic identifiers used on web pages that may contain keywords describing the page, to more advanced, highly structured, detailed, and standardised tags, such as those developed by Advanced Distributed Learning (2004), IMS Global Learning Consortium (2000), and the Learning Objects Metadata (LOM) working group of the IEEE's Learning Technology Standards Committee (2002). This type of metadata tag commonly contains information about: the type of object, author, owner; terms of distribution; format; and pedagogical attributes, such as the teaching or interaction style needed to use the learning object. These metadata tags are another important attribute of learning objects as users can search the metadata tags and find appropriate learning objects.

An example of the depth involved in these metadata tags can be seen in Figure 2-1 which shows the schematic representation of the hierarchy of elements in the LOM model. At the first level of this model there are nine categories, each of which contains sub-elements; these sub-elements may be simple elements that hold data, or may themselves be aggregate elements, which contain further sub-elements. The major advantage of this metadata approach is that it allows for the resources to be catalogued and stored, thus allowing them to be easily located by practitioners. This concept is similar to the Dewey Decimal classification system often used in libraries – just as library books can be easily located and borrowed by many people, the metadata tags allow for learning objects to be located and used by many people, but with the added advantaged of being reused by many people at the same time.

Please see print copy for Figure 2.1

Figure 2-1 A Schematic representation of the hierarchy of elements in the LOM model (Barker, 2005)

The metadata tags shown in Figure 2-1 provide potential for teachers to quickly and easily search for and locate relevant learning objects via Internet search engines or in specifically designed learning object repositories. Cohen and Nycz (2006) point out that there are two types of learning object repositories. The first type contains only the metadata for learning objects and the actual learning objects are stored in other various locations. The second type holds both the metadata and the learning objects in one location. A typical learning object repository allows registered or unregistered users to not only browse through material by subject or discipline but also to make simple or advanced queries. In a simple query keywords given by the user are matched against the information in a number of the metadata elements. Whereas an advanced query allows a user to specify values for specific metadata elements (Neven & Duval, 2002).

The two circled elements in Figure 2-1 “General” and “Educational” are of particular importance to teachers as they provide the searchable data specific to educational settings. The General element contains information about the title of the learning object, the language it is created for, keywords about it and other similar information. The Education element contains information specifically related to education e.g. the typical age range, the learning time, the type of interactivity needed to use it, etc. These two elements enable teachers to search for specific learning objects. Recent research investigating this process has been promising although several issues have appeared.

Heath, McArthur, McClelland and Vetter (2005) analysed five years of experience working with LOM in the iLumina digital library. They reported that pre-service teachers actively search the learning object metadata with the most commonly searched elements being from the General category. Their analysis also revealed that the usefulness of the other elements in the LOM model (e.g. Life Cycle, Meta-Metadata, Technical, etc.) were questionable, even suggesting that the semantic ambiguity of the subjective attributes of the Educational category made searching that category difficult.

Other studies (Najjar, Klerkx, Vuoikari, & Duval, 2005; Najjar, Ternier, & Duval, 2004) which examined the effectiveness of learning object metadata have also indicated mixed results. Such studies indicate that while novice and experienced trainers do search the repositories they sometimes have difficulty understanding the complex structure and vocabulary required often resulting in poorly generated search queries.

These findings suggest that if practitioners in this study (i.e., K-12 teachers) are to search learning object repositories in order to locate appropriate resources for lessons they are constructing, support must be given to them explaining how the repositories work and the importance of using suitable search terms and strategies.

Learning Objects must be Reusable

The second distinct characteristic of a learning object, according to Wiley's definition, is that it must be reusable. This implies that the object must be able to be used in a variety of contexts by a range of users. The assumption here is that teachers do not need to reinvent the wheel to create resources for their lessons; they can simply borrow, modify and use the content from the pre-existing resources. A metaphor commonly used to describe this is taken from the building industry (The Masie Center, 2003). This metaphor suggests that learning objects are like the pre-manufactured components used in the construction of modern buildings. For example, a door does not have to be measured and created by hand for every building. A builder can create a standard frame for a door and the owner can choose from hundreds of doors that will fit into the standard size doorframe. The same is true for windows, electrical outlets, etc. The house can still be tailored to the individuals needs, but the economies of scale make such personalisation possible for the average homeowner. It is this type of standardised approach that is also a major attraction for developers of learning objects. Their final products, just like pre-manufactured components in the building industry, can be used multiple times and in a variety of situations, therefore, minimising labour, easing management and subsequently reducing costs (Nurmi & Jaakkola, 2005; Woo, 2003). This is also important for K-12 teachers as it means once they have developed a lesson structure, like the framework of a house, they can then add components (i.e., learning objects) to customise the lesson to suit their situation requirements.

This notion of reuse is not without its problems. In practice questions exist about the feasibility and effectiveness of reusing learning objects in different contexts (Christiansen & Anderson, 2004; Mason, Pegler, & Weller, 2005; Nurmi & Jaakkola, 2005). A key issue relates to the size, or granularity, of the learning object (Banks, 2001; Fernandez-Manjon & Sancho, 2002; Ip, Morrison, & Currie, 2001; Wiley, Gibbons, & Wiener, 2000) where the more reusable a learning object becomes, the less useable it is. Parkin (2005) explains this by pointing out that the usability of a learning object varies in direct proportion to its size while its reusability varies in indirect proportion to its size. Parkin uses another metaphor from the building industry to explain this concept, with bricks, rooms and buildings:

> *"Bricks can be interchanged without affecting the harmony of a house design, whereas rooms cannot. The smaller your learning objects become, the easier it is to slip them in to other uses without creating any major disruption, but the less "meaningful" they are. The larger the objects become, the less re-usable they get, because they become more context-rich. But you get to a point where the size of the object is large enough to be self-fulfilling and truly meaningful, usually at the level of a house, or whole course"* (p.1).

The implication of this metaphor in a teaching and learning situation is that smaller, more reusable, learning objects (e.g., a five minute movie on clouds) require greater pedagogical involvement by the teacher, as the teacher needs to design their teaching and learning around the learning object or set of learning objects. Whereas larger learning objects (e.g., an entire unit of weather formations) require less work by the teacher, but can only be used in specific situations. Research investigating this concept is inconclusive though, with recent reports showing conflicting results. South and Monsoon (2002) designed and implemented a university wide system for creating, capturing and delivering learning objects at Brigham Young University in Utah. Through this case study of their experience South and Monsoon documented that the smaller or more granular a learning object is the more reusable it becomes. However in a similar case study (Conceição, Olgren, & Ploetz, 2006) where learning objects were used in a variety of higher education settings (e.g., blended online and classroom settings, online collaborative settings, and online self-paced settings) 14 faculty members reported via a questionnaire that a higher level of granularity was more effective. A larger study by Mason et el (2005) also reported similar findings to Conceição et al. (2006) when they used a variety of methods (interviews, questionnaires, and analyses of students' work) to assess the effectiveness of learning objects in tertiary settings. These inconclusive results suggest that more research is needed in this area, however for the purposes of this study the size of the learning object selected by participants will be left to the discretion of the participants.

Another interesting issue relating to the notion of reusability of learning objects is that the concept requires the developers of the learning objects to be willing to share their creations. This may sound obvious but in reality it has far wider implications particular if one considers the vast investments made and the complications that copyright could bring. This could potentially mean that schools would have to pay for individual learning objects or copy them illegally. Wiley and colleagues (2004) even suggested that these issues could lead to pirated copies of learning objects being traded on file sharing networks, and that this fear could stop developers from creating payment systems and even cease sharing altogether. Wilhelm and Wilde (2005) support this and add that the burden of dealing with copyright issues for learning objects could also block the sharing process altogether.

The concept of reusability is an important consideration in this study as McKenzie (1999) has revealed that teachers are more likely to use new technology if they see that it is relevant and that it can save time. Reusable learning objects have this potential as they can be used in a variety of situations and across a wide range of subject areas. For example a learning object describing the human heart could be used in science classes as well as in health classes.

Learning Objects must Support Learning

Finally, the last distinct characteristic of a learning object, according to Wiley's definition, is that it must support learning. This means that it must be able to be used to develop knowledge or acquire a skill. This is an important attribute because with other broader definitions a simple digital object, such as an advertising banner at the top of a web page, could be categorised as a legitimate learning object. Wiley's definition will limit the type and focus of digital resources available for teachers to use, as it will eliminate those objects which are not purposeful for learning.

These three distinct characteristics of a learning object (digital, reusable and able to support learning) are important for this study as they not only allow for specific resources, like the online curriculum content created by The Learning Federation initiative (The Learning Federation, 2003a), to be classified as learning objects, but they also allow for other useful educational resources available on the Internet to be classified as learning objects as well. Figure 2-2 and Figure 2-3 show examples of different digital resources that could be classified as learning objects according to Wiley's (2000) definition.

Please see print copy for Figure 2.

Figure 2-2 Lights, Camera, Action Film School, a learning object developed by The Learning Federation (2003b) for schools in Australia and New Zealand

Figure 2-2 shows a learning object created by The Learning Federation (2003b) specifically designed for Years 5-9. It is one of four in a series of learning objects that aims to immerse students in a broad repertoire of literacy practices. The focus of this Lights Camera Action series is to teach students the language and techniques of film-making. Students may enrol in the fictitious *Spellberg School of Film* and engage in interactive activities of movie making and story telling, before having their understanding tested through multiple-choice questions.

This series of learning objects, like the others developed by The Learning Federation, aims to enable students, both individually and collaboratively, to work with complex content and ideas in a new and dynamic way. These learning objects are designed to challenge students to question, investigate, analyse, synthesise, solve problems, make decisions, and reflect on their learning. These highly structured learning objects also provide feedback to students on their learning in a variety of supportive and engaging ways (The Learning Federation, 2003b).

Another type of a learning object which still is digital, still reusable and one that can still be used to support learning is shown below in Figure 2-3.

Please see print copy for Figure 2.3

Figure 2-3 The Pond Habitat of the Frog is a simple website with an educational purpose (Zephyrus Education, 2004)

This learning object, *The Pond Habitat of the Frog* (Zephyrus Education, 2004) is a single webpage that has been specifically designed for students aged 8 and above. The learning object presents factual information about the lifecycle and habitats of frogs in a linear fashion, where the user simply scrolls down through the webpage to read more information. Both this example and the example discussed earlier from The Learning Federation according to Wiley's (2000) definition can be classified as learning objects as they:

Are *Digital*: Both of these examples are stored on a computer and can be delivered across a network.

Are *Reusable*: Both of these examples can be used in a variety of curriculum areas and they can be used by multiple users at the same time. In terms of granularity, *The Pond Habit of a Frog* contains less specific information and is presented in a more general way enabling the learning object to be used in a wider variety of teaching and learning situations, therefore it has a finer level of granularity. Whereas the *Spellberg School of Film* has a very precise focus and thus can only be used in a few specific situations and therefore it has a coarser level of granularity.

Can *Support Learning*: Both of these examples have been design specifically to aid in the teaching of students.

The Utilisation of Learning Objects in School Education

In the last decade, governments around the world have shown continual support for the introduction of computer based technologies into classrooms. In the USA, the *Enhancing Education Through Technology* program, part of the No Child Left Behind (NCLB) Act, provided assistance in the form of funds and guidance for improving technology proficiency among educators and increasing technology use in classrooms (United States of America Department of Education, 2002). In the United Kingdom, a similar development happened through the *Fulfilling the Potential: Transforming Teaching and Learning through ICT in Schools* report. The report aimed to ensure that all schools in the UK use Information and Communication Technology (ICT) to make significant contributions to teaching and learning (Department for Education and Skills, 2003a). In Europe, the European Commission funded the *CELEBRATE* project (Context eLearning with Broadband Technologies, 2005). This 30 month project, completed in 2004, involved 23 participants from 11 countries creating and using a critical mass of new generation learning environments (i.e., learning objects). The Indian Government has also followed the same trend with the *Information Technology Action Plan* (National Task Force on Information Technology and Software Development, 1998) part of which involved the launch of “Operation Knowledge”. The aim of this national campaign was to universalise computer literacy and to spread the use of computers and information technology in Indian schools. While in Australia, the Ministerial Council for Employment, Education, Training and Youth Affairs (MCEETYA) endorsed a blueprint for the implementation of ICT in teaching and learning (New South Wales Department of Education and Training, 2002b). The overarching goals of the plan were that:

- *All students will leave school as confident, creative and productive users of new technologies, particularly information and communication technologies, and understand the impact of those technologies on society.*

- *All schools will seek to integrate information and communication technologies into their operations to improve student learning, to offer flexible learning opportunities and to improve the efficiency of their business practices* (New South Wales Department of Education and Training, 2002b).

As a result of this national directive the New South Wales State Department of Education and Training, introduced the *Public Schools: Strategic Directions 2002 - 2004* initiative (New South Wales Department of Education and Training, 2002a). This document emphasised the national goals and the NSW department's support towards achieving them. This support is still being shown, with NSW State Government allocating $795 million over the four year period from 2004 – 2008 for technology initiatives in NSW schools (New South Wales Legislative Assembly Hansard, 2004).

When these national and state directives and trends are combined with the international focus on the development of learning objects, it seems to be imperative that the learning objects are not only used, but used meaningfully. However, research shows that this is not necessarily happening. Recent studies (Caris, 2004; Griffith & Academic ADL Co-Lab Staff, 2003) have indicated that the uptake of learning objects by practitioners is still in its infancy. While these two studies focused on the tertiary sector, an Australian study by Hand et al. (2004) had similar findings in both the school and vocational training sectors. To add support to this, an international gathering of experts in the field of learning objects in 2002 had comparable thoughts and concluded that the current level of learning object activity could not be described as "pervasive" (Johnson, 2003). A panel discussion at the 2004 World Conference on Educational Multimedia, Hypermedia and Telecommunication concluded that there were still significant barriers to teachers' use of learning objects (Bennett et al., 2004). These findings are of even greater concern when you consider them with the reality that little attention has been paid to the pedagogical and practical implications affecting the use of learning objects in the K-12 environment (Butson, 2003; Parrish, 2004). This notion is further supported by authors (Anderson, 2003; Bush, 2002; Freebody, Muspratt, & McRae, 2007; Laurillard & McAndrew, 2003; Wiley, 2003) who suggest that more work is needed to develop strategies to make the process of incorporating learning objects as flexible and seamless as possible. This is emphasised in a study by Lake, Phillips, Lowe, Cummings, Schibeci and Miller (2004) which found that teachers needed encouragement to use learning objects. Lake et al. (2004) also recommended that some sort of support be provided for teachers to help them use learning objects in the development of teaching and learning resources. Given this, it seems imperative that a greater focus needs to be placed on providing teachers with suitable support to incorporate the use of learning objects into their teaching practice. An extensive longitudinal study commissioned by the U.S. Department of Education found that “professional development focusing on specific strategies for using technology… increases teachers use of these strategies” (Porter et al., 2000, p. 51).

One such strategy that has emerged from the literature as a possible way to develop teachers’ abilities to design lessons that make meaningful use of learning objects is through generic pedagogical frameworks or “learning designs” (Agostinho, Bennett, Lockyer, & Harper, 2003; Bennett et al., 2004; Griffith & Academic ADL Co-Lab Staff, 2003; Hand et al., 2004; Kang et al., 2003; Koper, 2001b; Laurillard & McAndrew, 2003; Lukasiak et al., 2004; Wiley, 2003).

This notion of providing teachers with professional development as a means to increasing their use of learning objects is an integral part of this study, as the research questions relate directly to supporting teachers use of learning objects with learning designs.

Learning Designs

Learning designs have been the focus point of various keynote addresses (Kraan, 2002; Laurillard, 2002), the subject of entire conferences (Australia Universities Teaching Committee Conference, 2002; The First International LAMS Conference, 2006) and the driving force behind a growing number of major initiatives, such as *The Learning Designs Project* (Agostinho, Bennett, Lockyer, Harper, & Lukasiak, 2005), the *Towards a Unified E-Learning Strategy* (Department for Education and Skills, 2003b), and the *Reusable eLearning Object Authoring and Delivery* Project (Reload, 2004). It has even been suggested that learning designs have the ability to revolutionise e-learning (Dalziel, 2003).

This recent ‘revolution’ in learning designs indicates that the concept is a new idea, however Sandy Britain (2004) suggests otherwise. He puts forward that in a traditional face-to-face teaching context teachers have engaged in the process of learning design as part of everyday lesson planning - the process of determining the resources used and the sequence of activities to be followed by a teacher and students when studying a topic. In a similar manner learning designs are described as "…the variety of ways of designing the sequence of activities and interactions within and between students and teachers" (Agostinho, Oliver, Harper, Hedberg, & Wills, 2002, p.30). While the central ideas behind lesson planning and learning design are similar, there are a few key underlying concepts that are the driving force behind this recent interest in learning designs. Weller, Little, McAndrew and Woods (2006) discuss these concepts and establish that:

- Learning designs can provide the structure and pedagogy for the sequencing of resources and activities, which can aid in supporting teachers as they design learning experiences.
- Learning designs can aid in describing an academic course in a generic format that can be shared between teachers, and technicians.
- Learning designs can be reused, meaning that they are created at a sufficient level of abstraction that they can be generalised beyond a single teaching and learning context.

These key points are important for this study as they provide, in part, the rationale for the combination of learning objects with learning designs by suggesting that a teacher can decide on a topic to be taught, select an appropriate pedagogical structure (i.e., learning design) and then incorporate resources (i.e., learning objects) into that structure. The key points above also point out that once this has been completed a teacher can then easily share this idea as the pedagogical structure will be in a standardised form.

This notion has been compared to cooking recipes (Dalziel, 2004) where different learning objects and interactions are the ingredients and the various learning designs are the preparation instructions. This metaphor implies that teachers, just like cooks, can take a recipe (or a learning design), then add or change ingredients (or learning objects) to suit their individual style or needs. It also means that teachers can describe lessons or courses to peers in a generic format, just like cooks can share their recipes, and finally the metaphor also suggests that learning designs, just like recipes, can be reused in a variety of settings depending on the context.

These concepts have intrigued researchers, with several teams (Agostinho et al., 2005; Botturi & Belfer, 2003; Goodyear, 2005; IMS Global Learning Consortium, 2003; Oliver, 1999; Oliver & Herrington, 2001; Oliver & Littlejohn, 2006; The LAMS Foundation, 2006) attempting to develop generic models for the implementation of learning designs for educational use.

The Structures of Learning Designs

Oliver (1999) and Oliver and Herrington (2001) were among the first researchers to investigate the structure of learning designs when they studied a wide range of online tertiary courses with the aim of identifying critical elements in the development of effective online educational resources. They concluded that the *resources* the learners interact with, the *tasks* the learners are required to perform, and the *support* mechanisms provided to assist the learners' engagement with the tasks are all critical elements in creating effective learning designs. Oliver and Herrington indicate this in a series of interconnected concentric circles. This can be seen in Figure 2-4.

Please see print copy for Figure 2.4

Figure 2-4 Elements of a learning design (Oliver, 1999; Oliver & Herrington, 2001)

Oliver and Herrington (2001) reported that the learning tasks shown in Figure 2-4 underpin and form the focus of learning designs, the learning resources help the learners' inquiry as they go about solving the tasks and, that the learning supports are the materials which enable the learner to complete the given learning task. The interconnectedness of the circles indicated that some items may be categorised under two or even three elements. For example, a worksheet could be seen as a possible task, but also as a valuable resource and, a structured assessment is one item that could possible be categorised under all three elements. Oliver and Herrington also reported that it is possible to include or omit any of these three elements in a design process, although they insist that these tasks, supports, and resources are essential elements in the make up of effective learning designs.

Since Oliver and Herrington's work, other researchers and organisations have attempted to produce generic learning design structures that can serve as pedagogical frameworks to support teachers in creating, delivering and/or sharing learning experiences (Agostinho et al., 2005; Botturi & Belfer, 2003; Goodyear, 2005; IMS Global Learning Consortium, 2003; Oliver & Littlejohn, 2006; The LAMS Foundation, 2006). While a lot of this work is still considered to be at the emergence phase (Conole, Oliver, Falconer, Littlejohn, & Hervey, 2006), several learning design structures have dominated current literature. Some of these learning designs include:

- IMS Learning Design (IMS LD) (IMS Global Learning Consortium, 2003)
- Patterns (Goodyear et al., 2004)
- The Learning Design Visual Sequence (LDVS) (The Learning Design Project, 2003)
- The Learning Activity Management System (LAMS) (The LAMS Foundation, 2006)

An overview of these learning design representations is discussed below:

IMS Learning Design (IMS LD)

The IMS Global Learning Consortium (2003) set out to develop a way to represent units of learning, the IMS term for learning design, that would be technically interoperable across various learning management systems. The outcome of the initiative was IMS LD, a standardized way of documenting units of learning (learning designs) in a computer readable format (an XML file) which can then be played on an IMS LD 'player'. The IMS LD represents units of learning as a succession of specifically selected activities. It describes the tasks the learners are to perform, the resources required to complete the tasks, and the roles (supports) that the students and teachers assume for each activity. The IMS Global Learning Consortium thought that by creating a technically interoperable system the constructed units of learning would have greater reuse.

Initial investigations (Koper & Olivier, 2004; Koper & Tattersall, 2005) into the practical application of IMS LDs have revealed promising results. Koper and Olivier (2004) even suggested that an IMS LD can support the more informal aspects of learning that takes place in learning communities. Other studies have uncovered issues associated with application of an IMS LD approach. McAndrew and Goodyear (2007) reported that practitioners were hesitant to adopt an LIMS LD approach largely due to the technical expertise needed and the time involved in creating a learning design.

Patterns

Patterns (Goodyear et al., 2004) offer another approach to creating and sharing learning knowledge. Patterns were originally devised in the 1970s by Christopher Alexander (McAndrew & Goodyear, 2007) for use in an architecture environment to describe general forms of the trade. Patterns are presented in textual paragraphs and contain information about the learning context. This includes a description of the problem, a solution or instructions, as well as links to other patterns which may support/inform this pattern. The patterns are deliberately designed to be abstract rather than a complete package like the IMS LD, thus allowing for human intervention and variation in each reuse (Goodyear, 2005). An example of a pattern is given in Figure 2-5.

Please see print copy for Figure 2.5

Figure 2-5 A design pattern focusing on a Group Discussion (Goodyear, 2004)

This pattern approach has been widely advocated by technical developers as a way of providing standardised, teacher-friendly representations of learning designs (Burgos & Griffiths, 2005). However, Falconer and Littlejohn (2006) suggest that currently teachers use of patterns is limited.

The Learning Design Visual Sequence (LDVS)

One team of researchers from Australia (The Learning Design Project, 2003) developed a way to graphically represent learning designs with the purpose of helping academics in higher education implement innovative ICT based learning designs to use in their own teaching contexts. This formalism, based on the earlier work of Oliver and Herrington (2001), uses the same three key elements (tasks, resources and supports) identified earlier in conjunction with accompanying text to diagrammatically represent a range of learning designs. An example of one of these LDVS can be seen in Figure 2-6:

Please see print copy for Figure 2.6

Figure 2-6 An example of a LDVS formalised by the Learning Designs Project (Agostinho et al., 2005)

The structure of the Predict, Observe, and Explain learning design visual sequence illustrated in Figure 2-6 portrays the three key elements in columns along with arrows and text to demonstrate the flow and chronology of the design. This standardised approach is used throughout LDVS and has proved to be successful at describing a variety of pedagogically sound learning design taxonomies including, but not limited to problem-based learning designs, case studies, role-plays and, collaborative learning designs (Harper, Agostinho, Bennett, Lukasiak, & Lockyer, 2005). Having this taxonomy of learning designs enables teachers to select a design appropriate to their needs and then add content (which can be in the form of learning objects) to create a lesson, or series of lessons.

A small scale study conducted by Bennett, Lockyer, and Agostinho (2004) followed a team of four lecturers at the University of Wollongong as they re-designed a university course using the LDVS. Preliminary findings from an analysis of interviews, observations, discussions and artefacts produced by the participants indicated that the LDVS was useful in the initial phase of the re-design process. However, the researchers concluded that further analysis and research was needed to reveal more information about how the LDVS can support the integration of learning objects.

The Learning Activity Management System (LAMS)

The Learning Activity Management System, managed by Macquarie University in Australia (The LAMS Foundation, 2006) is similar to the LDVS in that it enables teachers to plan and deliver technology supported learning. However LAMS is an electronic system that uses a flexible “drag and drop” interface to combine and organise discrete tasks. The system was created to support innovative and effective online learning and to facilitate the sharing and reuse of the learning activities (Falconer & Littlejohn, 2006). A screen capture of the LAMS approach to learning design can be seen in Figure 2-7.

Please see print copy for Figure 2.7

Figure 2-7 A LAMS representation of a learning design (The LAMS Foundation, 2006)

This screen capture provides a visual representation of what activities have been selected and the sequence in which they are to be conducted. LAMS also has the built-in ability to deliver the constructed learning design and make use of online resources (or learning objects). LAMS International (2007) states that this process is successfully being used in over 22 countries.

While the four frameworks, IMS LD, Patterns, LDVS and LAMS, all appear to be different they do have several commonalities, that is, the fundamental structure of these initiatives can be compared, in most cases, directly to the three elements of a learning design identified earlier by Oliver (1999) and Oliver and Herrington (2001). This process can be seen in Table 2-2.

Table 2-2 The comparison of terminology between four learning design frameworks and the three elements of a learning design

		Four Learning Designs Frameworks			
		IMS LD	**Patterns**	**LDVS**	**LAMS**
Three Elements of a Learning Design	**Learning Tasks**	Tasks	Tasks are informed by the Problem	Tasks	Activities
	Learning Resources	Resources	Space (tools & resources)	Resources	Resources
	Learning Supports	Roles	The solution & organisational forms	Supports	Built in supports

Table 2-2 shows that although the four frameworks do not always use the same terminology, the specific terms used by the different frameworks can be related back to the three elements of a learning design identified earlier (Oliver, 1999; Oliver & Herrington, 2001). For example: the tasks in the IMS LD and LDVS, along with the activities in LAMS and the problem in Patterns all contain similarities to the Learning Task element of a learning design. Likewise the three resources and tools associated with the initiatives are all similar to the learning resources outlines by Oliver and Herrington.

While these similarities and the research associated with the learning design frameworks point towards the general success of the learning designs approach, there is a practical issue associated with their use. This issue relates to what size, or level of granularity, a learning design should be.

In theory, learning design frameworks can be used to describe an educational process at any level of granularity. At the larger end of a continuum, an entire educational program or course consisting of a series of subjects could be described as having a coarse level of granularity. A medium level of granularity could be used to describe a single subject within a course, while a learning design with a fine level of granularity could describe a single lesson. However in practice, where Koper and Miao (in press) have suggested that a learning design created with an appropriate level of granularity can maximize the ease of use, reuse and manageability of the learning design, this notion of granularity becomes a real concern and an area for future research.

Another noticeable gap in educational research relating to the use of learning designs has to do with the disproportionate amount of research conducted in tertiary settings, when compared to the amount of research conducted in the K-12 setting. There is however, one type of online pedagogical framework that has been extensively used in the K-12 setting for over 10 years. This pedagogical framework is said to be the most widely known learning tool on the Internet (Hill, Wiley, Nelson, & Seungyeon, 2003). It is this pedagogical framework, known as a WebQuest, that this study will adopt as a learning design framework.

WebQuests

In 1995, Professor Bernie Dodge and his colleagues from San Diego State University developed the concept of a WebQuest – a model for integrating the use of the World Wide Web (WWW) into classroom activities. Since then WebQuests have been implemented across all areas of the school curriculum, from learning about exotic cultures in Social Studies (Milson, 2001), making videos in Geography (Lara & Repáraz, 2005), educating students about literature skills (Truett, 2001), promoting Health Education (Anon, 2004), developing higher order thinking in mathematics (Crawford & Brown, 2002) to challenging science based activities (Kahl, Horwitz, Berg, & Gruhl, 2004). WebQuests have been used across all grade levels from children to adults (Hill et al., 2003).

WebQuest – A definition

In 1995 Dodge defined a WebQuest as:

> "*an inquiry-oriented activity in which some or all of the information that learners interact with comes from resources on the Internet*" (Dodge, 1995).

This definition first describes WebQuests as being "inquiry-oriented activities" indicating that Dodge believes WebQuests involve the process of exploring, questioning and discovering in the search for new understandings (Exploratorium Institute For

Inquiry, 1996). Jonassen, Howland, Moore, & Marra (2003) suggest that this process is not only effective, but also an educationally valid use of the Internet.

Dodge's definition also suggests that some or all of the information the learners interact with while using WebQuests comes from resources on the Internet. This is extremely pertinent to this study as resources available on the Internet that can be used for learning are defined as learning objects (Wiley, 2000).

The issue of granularity is also evident in WebQuests, where two levels of WebQuests exist: short term and long term. The instructional goal of a short term WebQuest (designed to be completed in one to three class periods) is knowledge acquisition and integration. Long term WebQuests typically take between one week and a couple of months in a classroom setting and after completing it a learner will be expected to have analysed a body of knowledge deeply, transformed it in some way and demonstrated an understanding of the material by creating something that others can respond to (Dodge, 1995).

Critical Attributes of WebQuests

Dodge and a colleague, Tom March (March, 2004), spent considerable time developing the key attributes of a WebQuest. They wanted something that would combine authentic tasks with Internet resources in order to develop critical thinking skills. Dodge (1995) established that there were six critical attributes of the WebQuest framework:

1. An **introduction** that sets the stage and provides some background information.
2. A **task** that is doable and interesting.
3. A set of **information resources** needed to complete the task. Many (though not necessarily all) of the resources are embedded in the WebQuest document itself as anchors pointing to information on the World Wide Web. Information sources might include web documents, experts available via e-mail or real-time conferencing, searchable databases on the net and books and other documents physically available in the learner's setting. Because pointers to resources are included, the learner is not left to wander through web space completely adrift.
4. A description of the **process** the learners should go through in accomplishing the task. The process should be broken out into clearly described steps.

5. Some **guidance** on how to organize the information acquired. This can take the form of guiding questions, or directions to complete organizational frameworks such as timelines, or concept maps, etc.
6. A **conclusion** that brings closure to the quest, reminds the learners about what they've learned, and perhaps encourages them to extend the experience into other domains.

These attributes have changed little over the past decade, with the main difference being the inclusion of an evaluation section (at the expense of the guidance section) which describes to the learner how their performance will be evaluated, thus giving them direction on how to organise their work (Dodge, 2005).

Using these six attributes as a base Dodge (2003) developed a variety of WebQuest design patterns. This taxonomy of patterns was derived from existing WebQuests that were deemed to be instructionally sound. The design patterns were created to provide teachers with a range of easily modifiable themed WebQuest templates. Dodge (2003) provides over 25 WebQuest design patterns organised in terms of the dominant thinking verb that underlies them i.e., design, decide, create, analyse and predict. These WebQuest design patterns range from commemorative events to travel plans about possible holidays and from analysing topics for bias to simulated diaries of a particular individual in a specific time or place.

The WebQuest model, including these design patterns has been the centre of numerous investigations which look at the validity of the model as a way of supporting learning. Chan (2007) looked at how a WebQuest model could be used as an alternative to traditional instructor-centred teaching at the University of Hong Kong. She designed and developed a long-term 14-week WebQuest that 125 engineering students could use to learn the topic of Simulation and Statistical Analysis. Through her own quantitative analysis, which consisted of interviews with students and self reflection, Chan reported that positive significant ($p<.05$) changes were recorded in student interest levels when studying using a WebQuest, and that students were more motivated to learn using WebQuest. She did however find that those students who normally perform well in traditional examination-oriented assessment models still preferred to be evaluated by assignments and examinations. Despite this Chan concluded that both the qualitative and quantitative data revealed that the pedagogy behind the WebQuest model was effective.

Boling (2003) also investigated the WebQuest framework when she looked at the impact that WebQuests had on student engagement and whether a student’s locus of control was related to their success with the WebQuest. Her findings suggested that WebQuests are engaging, enjoyable and beneficial to students. In addition, she noted that more than half of the 145 students in the study were observed as being authentically engaged throughout the entire learning activity. Boling concluded that student choice, the opportunity to use computers, and the authenticity of the tasks appeared to be factors that led the students’ collective interest in the WebQuest approach to teaching and learning.

Supporting these quantitative studies, Lipscomb (2003) conducted a qualitative study investigating how teachers use WebQuests in the classroom. He observed, recorded and analysed two eighth grade classes as they worked through and completed a WebQuest on the American Civil War. Lipscomb reported that the students gained a great deal of knowledge on the topic of the civil war and that the students enjoyed themselves at the same time. Lipscomb also found that the teachers were able to address many of the state’s Social Study standards by using a WebQuest approach to teaching and learning.

To add to these findings an in-depth study (Gorghiu, Gorghiu, González, & García de la Santa, 2005) investigating how 323 teachers responded to an online professional development course about WebQuests also had positive results. The researchers reported that WebQuests were found to be an important source of inspiration for teachers and that teachers encountered few obstacles when developing and implementing WebQuests. The researchers also found that WebQuests were a successful way of integrating the Internet into a teaching and learning experience.

The results from these qualitative and quantitative studies are important for this research project for a number of reasons. Firstly, the studies point to the success of the WebQuest model as a rich instructional approach for promoting inquiry in the K-12 setting. Secondly, they suggest that through professional development teachers can successfully create WebQuests that incorporate resources form the Internet.

WebQuests as Learning Designs

The WebQuest model can be seen to represent the three areas of a learning design; tasks, resources and supports, proposed earlier by Oliver (1999) and Oliver and Herrington (2001). With the WebQuest task being very similar to the learning task, the WebQuest resources equally represent the learning resources, and the process, and guidance/evaluation sections of the WebQuests closely resembling the learning supports. A comparison between the structure of learning design framework and the WebQuest framework can be seen below in Figure 2-8.

Learning Designs		**WebQuests**
Three Elements in a Learning Design		***Six Critical Attributes of WebQuests***
Learning Supports	→	Introduction
Learning Tasks	→	Tasks
Learning Resources	→	Information Resources
Learning Supports	→	Process
Learning Supports	→	Evaluation/Guidance
Learning Supports	→	Conclusion
Learning Design Taxonomies		***WebQuest Design Patterns***
Various learning design taxonomies, depending on the type of learning design representation	→	Five categories of design patterns, incorporating over 25 designs, including: design, decision, analysis, prediction and creative tasks

(N.B. Arrows indicate similarities between the attributes and elements)

Figure 2-8 The similarities between WebQuests and Learning Designs

Figure 2-8 illustrates how the six critical aspects of Dodge’s WebQuest model are in line with the three elements of learning designs identified by Oliver (1999) and Oliver & Herrington, 2001). The table also indicates how the WebQuest design patterns or templates are similar to the taxonomies of learning design put forward by several of the leading learning design representations. These WebQuest design patterns, or templates, are derived from instructionally sound WebQuests and are easily modifiable to cover different content using the same basic structure (Dodge, 2002).

Identifying WebQuests as a type of learning design framework is an important step in this study, as it is now possible to theorise that a learning design in the form of a WebQuest can be used to assist K-12 teachers as they try to create pedagogically sound learning experiences which incorporate learning objects. The use of WebQuests can achieve this as they provide a pedagogical framework which teachers can follow. This idea is not without its problems as it relies heavily on the process the teachers must go through in order to create their WebQuests. This process not only includes designing the six critical attributes of a WebQuest, but also locating and selecting appropriate learning objects to include as resources in the contextualised WebQuest. To ensure that this happens, teachers must have appropriate support to guide them through the process. One method that has the potential to not only guide teachers through this process but also do it in a time efficient manner is through scaffolding the design process.

Scaffolding

The concept of scaffolding was first used by Wood, Bruner and Ross (1976) to describe the temporary, but essential nature of support that parents give their children during language development. Since then, Wood et al.'s (1976) concept of scaffolding has been extensively used in educational literature to describe the assistance given by a teacher, or peer, to enable a learner to accomplish a task, skill or understanding which they would not have been able to manage on their own. This concept of scaffolding closely resembles Vygotsky's (1978) notion of the zone of proximal development. Vygotsky suggested that there are two parts of a learner's developmental level, the "actual developmental level" and the "potential developmental level". The zone of proximal development is "…the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). Vygotsky continued and described scaffolding as the role of teachers and others in supporting the learner's development and providing support structures to get to that next stage or level. An important characteristic of scaffolding is that the scaffolds are temporary. As the learner's abilities increase the support provided by the more knowledgeable other is progressively withdrawn, until finally the learner is able to master the task or concepts independently.

During 1990's the traditional concept of scaffolding started to evolve and become broader, with researchers suggesting that scaffolding could refer to any form of tool, not just a teacher or peer, that could assist the learner in making progress on what would otherwise be out of their reach (Davis & Linn, 2000; Edelson et al., 1999; Quintana et al., 1999; Reiser et al., 2001). In further work, Reiser (2002) points out that scaffolding describes any type of structure that helps make learning more tractable for learners, therefore allowing the learner to accomplish more ambitious tasks. In this sense, learning designs on their own can be classified as a type of scaffolding as they provide the necessary structure to guide teachers (who are the learners in this situation) through the pedagogical aspects of designing the teaching and learning experience.

Research on teaching and learning in a school setting supports this scaffolding theory and reveals that scaffolding instruction can guide the learner to independent and self-regulated competence as well as improving the learner's cognitive abilities (Chang, Chen, & Sung, 2002; Ellis, Larkin, & Worthington, 2001; Toth, Klahr, & Chen, 2000). Research involving teacher development, in this case pre-service teachers, also supports this theory. In 2001 Love and Shrimpton investigated the effectiveness of a video-based interactive CD ROM training package on two large cohorts of pre-service teachers (approx. 1000 each). The package entitled BUILT (Building Understandings in Literacy and Teaching) was designed to address concerns about pre-service teachers' knowledge on language and literacy across the school curriculum. Love and Shrimpton stated that the "…most important principle guiding the development of BUILT, central to both its instructional content and its instructional design, was that of scaffolding" (2002, p. 4). Specifically, Love and Shrimpton commented on how the principles of scaffolding enabled the novice teachers to develop new professional understandings as they moved recursively through the authentic learning activities incorporated into BUILT. Love and Shrimpton's case study revealed strong positive feedback about the structure of the training package, with 86% of their participants seeing strengths in the design of the package, with two thirds of the participants indicating that the training package was "…very effective or reasonably effective in scaffolding their knowledge" (2002, p. 7).

The supporting research underlying the design principles of BUILT was examined as part of an extensive literature review conducted by Hogan and Pressley (1997) when they successfully identified eight essential elements that teachers could use as guidelines when scaffolding teaching and learning experiences. These guidelines include:

- Pre-engagement with the student and the curriculum
- Establish a shared goal
- Actively diagnose student needs and understandings
- Provide tailored assistance through cueing or prompting, questioning, modelling, telling, or discussing
- Maintain pursuit of the goal by asking questions and giving praise.
- Give feedback to monitor progress
- Control for frustration and risk by creating an environment in which the students feel free to take risks with learning
- Assist internalization, independence, and generalization to other contexts by helping students to be less dependent on the support

These guidelines, while specifically designed to aid teachers as they scaffold learning experiences for their students, can easily be translated to aid instructional designers as they scaffold learning experiences (i.e., professional development) for teachers. An example of this would be translating the first guideline *Pre-engagement with the student and the curriculum*, to *Pre-engagement with the teacher and the task*, where the task is to develop a WebQuest. By applying a combination of these scaffolding guidelines to this study it can be theorised that scaffolding can be used to support teachers as they learn to develop learning designs which incorporate learning objects. While this specific area has not been extensively researched, there is one tool that could possibly provide teachers with the support and guidance needed to construct a meaningful WebQuest. This type of scaffolding structure falls under the broader description of what is commonly referred to as a cognitive tool.

Cognitive Tools

Cognitive tools are aids that enhance a user's cognitive abilities during thinking, problem solving and learning (Jonassen & Reeves, 1996). In the simplest and earliest form a cognitive tool could be an abacus, or even piles of small stones, used to calculate sums. Modern cognitive tools, however, are much more powerful and are seen as computer tools that are intended to engage and facilitate cognitive powers of the learner in order to solve difficult tasks (Jonassen, 1994; Reeves, Laffey, & Marlino, 1997). Jonassen and Reeves (1996) assert that a well designed cognitive tool has the ability to not only aid the user in acquiring necessary skills, but also to promote a deeper level of thinking and information processing. Jonassen (1996) adds further support to this when he points out that cognitive tools can make it easier for learners to process information, but that their main goal is "…to make effective use of the mental efforts of the learner" (p. 10). This does not mean that cognitive tools make the actual task easier, or reduce the amount of information processing required, it means that a well designed cognitive tool can activate cognitive and meta-cognitive learning strategies, therefore complimenting and extending the mind of the user (Jonassen, 1992). It is in this sense that cognitive tools become not only powerful, but also extremely useful to this study as they have the potential to engage teachers in higher order thinking as they synthesise information to create a pedagogically sound learning design, which incorporates learning objects.

Susanne Lajoie in the second volume of her book "Computers as Cognitive Tools" (2000) discussed the benefits of a cognitive tool approach to learning. She summarised that a cognitive tool has the ability to support the cognitive process, share the cognitive load, and allow the user to engage in activities that would otherwise be out of their reach. By relating these benefits to the proposed cognitive tool required in this study it can be theorised that a specifically designed support system will provide the necessary scaffolding to assist teachers as they create pedagogically sound learning designs which incorporate learning objects – a process which could potentially be out of the reach of some teachers.

These benefits and how they relate to the proposed cognitive tool required in this study can be seen below in Table 2-3.

Table 2-3 Lajoie's (2000) benefits of a Cognitive Tools approach to learning and how they relate to this study

Please see print copy for Table 2.3

In order to achieve these benefits Jonassen (1994) insists that a learner who uses a cognitive tool must actively engage in, think deeply about and articulate any new knowledge. Kennedy and McNaught (2001) emphasise these key points and suggest that in order to mediate cognition a computer-based cognitive tool, like the tool proposed in this study, should:

- engage the student actively
- support a deep approach to learning
- provide support for a student to articulate their knowledge
- be embedded in an educational environment or context with a particular educational intent.

One type of cognitive tool that incorporates these aspects and that has been used, tested and found to be successful in educational settings is an Electronic Performance Support System (Gery, 1989, 1995).

Electronic Performance Support Systems as Cognitive Tools

Gery (1989), along with her training developers, first coined the term Electronic Performance Support System, or EPSS. Gery and Raybould then agreed on a basic definition of a EPSS, as an electronic system that provides integrated access to information, advice, learning experiences and tools to help someone perform a task with the minimum of support by other people (Gery, 1991; Raybould, 1990). Gery went on to state that a major goal of an EPSS is “…to provide whatever is necessary to generate performance and learning at the moment of need” (1991, p.34). This definition, along with others that evolved from it (Laffey, 1995; Raybould, 1995; Weber, 2002) all vary slightly, but they generally agree that an EPSS is “…a system that provides the user with information, guidance and learning experiences wherever and whenever a user needs it” (Desrosiers & Harmon, 1996, p.1).

The main benefits of implementing an EPSS as a type of cognitive tool are summarised by Cote (1998) who articulates that an EPSS provides:

- No delay between refresher training, and the moment the knowledge is required
- The user with access to the latest information and procedures
- Expert and detailed advice when required
- Potentially large savings for the organisation.

EPSSs in Education

While electronic performance support has been widely accepted and developed in the business world as a viable alternative to more traditional training (Gery, 1991) the use of an EPSS as a type of cognitive tool in the education sector is relatively new. However there have been several studies that have found that teachers can benefit in numerous ways from the support of an EPSS. One example is *Teacher Tools* (Orey, Moore, Hardy, & Serrano, 1997) where an EPSS has been designed and developed to improve a teacher's ability to perform a myriad of tasks, from lesson planning to behaviour management. A recent study on this EPSS (Moore & Orey, 2001) found that teacher performance of tasks did increase as a result of using the *Teacher Tools* program. However, these results are limited due to the limited sample size (n=8) and the inconsistent participation of the teachers, with only 50% completing the testing. *Support for Teachers Enhancing Performance in Schools* (STEPS) is another EPSS tool available on the World Wide Web that aims to assist teachers in planning and implementing lessons that align to Florida State Standards (Northrup, Pilcher, & Rasmussen, 2000). The just-in-time concept was the driving force behind this EPSS and this technology means that Florida teachers can receive professional development at times and places convenient to them. STEPS includes eight components, with the major one being a *Lesson Architect*. The scaffolding within this component guides teachers as they work through a series of templates to design lessons at a time convenient to their schedules. Although a formal evaluation of STEPS has not been undertaken Northrup & Pilcher (2003) believe that the demand for the continuation and growth of STEPS is evidence of the success of the system.

A larger scale international study that implemented and tested an EPSS in the education sector is the *Computer Assisted Curriculum Analysis, Design, and Evaluation* system (CASCADE). The CASCADE project (Nieveen, 1997) aimed to learn more about how EPSSs could contribute to the area of curriculum development. In particular this developmental research study focused on the design and development of an electronic system to support professional Dutch curriculum developers through the complex process of planning, and executing formative evaluation activities. The results showed that that the EPSS developed for this purpose - CASCADE - helped users to improve the consistency of formative evaluation plans and activities, motivated developers by elevating their confidence in being able to conduct formative evaluation tasks, saved time and helped to provide justification for resulting decision-making. Such findings were encouraging and prompted further research. Subsequently two follow-up studies were initiated which used the CASCADE project as a springboard for further exploration into computer supported curriculum development in very different contexts. The CASCADE - SEA (Science Education in Africa) study (McKenny, 2001) investigated the support of teachers creating exemplary lesson materials for classroom use. While the CASCADE - MUCH (MUltimedia curriculum design in CHina) study (Wang, 2001) examined the support of teachers designing multimedia scenarios in China. In 1999, a third CASCADE study was launched: CASCADE - IMEI (Innovative Mathematics Education in Indonesia) (Zulkardi, Nieveen, van den Akker, & de Lange, 2002). This version supports student teachers in Indonesia through the creation of lesson materials for realistic mathematics education.

Research (McKenney, Nieveen, & van den Akker, 2002) looking at the success of the CASCADE series of support systems suggests that the EPSSs developed meet the criteria of validity, practicality and effectiveness. The researchers conclude that EPSSs in general are well-suited to supporting processes the users must go through, however the researchers also point out that the EPSSs are not likely to be able to provide support for all situations.

On a smaller scale, the Lesson Planning System (LPS) is an Australian designed, developed and tested EPSS that aims to enhance the lesson planning skills of first year education students at Edith Cowan University (Wild, 2000). The LPS incorporates the model of lesson planning required by the university. It addresses essential components of the lesson planning tasks such as writing learning objectives, developing learning experiences and planning evaluations. Each of these components is supported by activities that instruct the user about the task e.g. provision of information relating to reasons why objectives are necessary, criteria for quality objectives. The EPSS also assists the user in performing the task (e.g. provision of a database of verbs to assist in writing quality learning objectives).

The LPS is based on the premise that students, by using the LPS, will come to understand the processes involved and be able to plan lessons effectively, both through their use of the LPS and also by other means (e.g. pen and paper). The results from the testing demonstrated that the students who used the LPS developed expertise in lesson planning and were able to utilize their newly acquired skills and knowledge to design lesson plans without the aid of the LPS (Wild, 2000).

These EPSSs and the findings associated with the research conducted on them suggest that a cognitive tool in the form of an EPSS can have a positive effect in an educational context. This conclusion adds further support to the notion that a specifically designed and developed EPSS could assist teachers as they attempt to combine learning objects with learning designs.

Guidelines for Developing a Cognitive Tool in the Form of an EPSS

There is wide consensus that there is a lack of well defined EPSS design and development models (Gustafson, 1993; Gustafson, 2000; Laffey, 1995; Milheim, 1997; Rosenberg, Coscarelli, & Hutchison, 1999). It has also been noted (Cagiltay, 2001) that there is insufficient information about how people have designed and developed EPSSs. Gustafson (2000) has suggested that there are three main reasons for this lack of information.

Firstly, like others (Winer, Rushby, & Vazquez-Abad, 1999) he believes that many EPSSs are developed by commercial organisations who have strict confidentiality regulations to help maintain a competitive edge, consequently these organisations do not share their information. Secondly, Gustafson believes that as the history of EPSSs is relatively young, the procedures behind their development have not been well tested. This view supports Grey's (1995) early suggestion that because of the short history of EPSSs it is difficult to define a detailed design model for an EPSS. Gustafson's third reason for the lack of information about the design and development of EPSS is that "…some EPSS designers may be reluctant to talk about what they have done, since they are unable to clearly articulate specific and replicable procedures" (Gustafson, 2000, p. 42).

This lack of information about the design of EPSSs has made designers try different approaches. Some have used classical instructional design approaches (Benko & Webster, 1997; Graham & Sheu, 2000), others have tried rapid prototyping (Cole, Fischer, & Saltzman, 1997; Tripp & Bichelmeyer, 1990), prototyping and layers of necessity (Northrup & Pilcher, 1998; Wedman & Tessmer, 1991), chaos theory (Cagiltay, 2001) and different combinations of the above (Gustafson, 2000). However, researchers (Rosenberg et al., 1999; Wilson, 1999) have stated that these models have several limitations in performance support system development, with the most significant problem being that these models generally analyse the job tasks to identify whether someone can perform them or not. Because of this Raybould (2000) has emphasised that the methodology for developing EPSSs must have a wider scope than other existing methodologies. Other researchers (Gustafson, 2000; Hannafin, Hill, & McCarty, 2000) have also affirmed this view and welcome the use of other approaches.

One type of development model that has recently been identified (Cole et al., 1997; Villachica & Stone, 1999) as having the ability to offer detailed strategies that could be applied to EPSS creation comes from Information Systems. Information Systems design methodologies require that "…the steps are prescribed in great detail and are expected to be followed" (Avison & Wood-Harper, 1990, p. 13). This procedural foundation of the Information Systems approach requires a linear design, can easily be represented using a flowchart. Johnson (2003) points out that using a flowchart greatly increases the probability of completing a successful design with a minimum of time and expense, as well as this Johnson suggests that this method aids in finding design flaws early in the design process. LeLoup and Ponterio (2003) support this, and add that flowcharts help to keep people focused on the final goal.

By integrating these strategies with the eight essential elements of scaffolding (Hogan & Pressley, 1997) and the four key points underlying cognitive tools (Jonassen, 1994; Kennedy & McNaught, 2001) the following guidelines were created:

1. The use of a flowchart is recommended
2. The design should be linear
3. A system should actively engage the learner by developing and maintaining a shared goal
4. A system should provide detailed steps with tailored assistance though cueing, prompting, questioning, modelling, telling and/or discussing
5. A system should provide a deep approach to learning

These guidelines cover the relevant elements, points and strategies identified in the literature about the development of scaffolding, cognitive tools and EPSSs in education. It is these five guidelines that will form the basis of the initial prototype EPSS developed for this study.

Summary

Responding to the limited use of learning objects in the K-12 environment, several researchers have suggested (Agostinho et al., 2003; Bennett et al., 2004; Hand et al., 2004; Kang et al., 2003; Koper, 2001a; Laurillard & McAndrew, 2003; Lukasiak et al., 2004; Wiley, 2003) that the use of learning designs should be investigated as a possible approach to assisting teachers as they incorporate this new technology into their classrooms.

In order for teachers to easily create a broad range of teaching and learning experiences, using this approach it is important that appropriate support is introduced to aid teachers through the process. It is also important that professional development is employed to inform teachers of the process. This study aims to achieve this by designing a cognitive tool as a type of scaffold, to aid and direct teachers through the process of combining learning objects with learning designs, and by providing professional development time to do this. Cognitive tools, in the form of EPSSs, have been successful in supporting teachers' to become competent in activities that would otherwise be out of their reach (Gery, 1989, 1995; McKenney et al., 2002). Therefore, it can be theorised that the use of a cognitive tool in this study would successfully aid teachers in developing pedagogically sound learning designs that make use of state of the art learning objects.

CHAPTER 3

Methodology

Introduction

This chapter details the research methodology utilised to investigate what systems and supports can be designed and developed to assist teachers to integrate learning objects into a learning designs framework. The chapter begins with a literature review of the research methodology used in the study, along with justification for its choice. The research was conducted in six stages, and the research procedures for each stage are described in detail, including the data collection and analysis techniques utilised to address the research questions. The chapter concludes with a discussion of the ethical considerations and a summary of the methods used to ensure the reliability and validity of the research.

Research Approach

The study focused on addressing three research questions:

1. *What are the issues that teachers face as they combine learning objects with learning designs?*
2. *What design principles guide the development of systems and supports which assist teachers as they combine learning objects with learning designs?*
3. *How do systems and supports address the issues teachers face as they combine learning objects with learning designs?*

Accordingly, it was necessary to situate this study within an appropriate research paradigm. When it comes to selecting which particular type of research methodology to use, Guba (1981) suggests that "…it is proper to select that paradigm whose assumptions are best meet by the phenomenon being investigated" (p.76). Howe and Eisenhart (1990) add to this and emphasise that the methodology employed should be judged in terms of its success "…in investigating problems deemed important" (p.2).

Gibbons and Bunderson (2004) suggests three different types of possible research: explore, explain, and design. They define explore research as a type of research aimed at producing observations that can lead to category formation and formation of hypotheses of relationships; explain research as denoting the familiar goal of scientific research, which is to explain why and explain how phenomenons occur; and, design research as the process of applying, structuring and synthesising principles in order to create new artefacts.

It is the process of design research, as well as the ability of the research to create new artefacts, that grasp the developmental nature of the research questions associated with this study. The questions require a methodological approach that allows for systems and supports for teachers to combine learning objects with learning designs to be developed. Design research purports to do this.

Development Research, a term synonymous with design research (Reeves, 2000), focuses on solving broad based, complex, real world problems that are critical to education, while at the same time maintaining a commitment to theory construction and explanation (Reeves et al., 2004). This approach also aims at making both practical and scientific contributions in the chosen field (van den Akker, 1999) which Shavelson and Towne (2002) believe is of importance to the educational field. Given this and the continuous design, development and evaluative nature of the research project, it was decided to ground the methodology for this project in the theoretical framework of development research.

The concept of development research is frequently traced back to the work of Ann Brown (1992) and Allan Collins (1992). They both conducted *design experiments* and looked at how they were developed as a way to carry out formative research to test and refine educational designs based on principles derived from prior research. Cobb, Confrey, diSessa, Lehrer, & Schauble (2003) have pointed out that, since Brown and Collins work, development research has been used in a wide range of educational settings. These settings have ranged from one-on-one situations where the research is conducted on individuals or small groups of students, through to experiments which involve entire school communities. An overview of these settings can be seen below in Table 3-1.

Table 3-1 An Overview of the Scope of Development Research in Educational Settings

Type of Development Research	Description
One-On-One	Involves experiments where the researcher(s) conducts a series of teaching sessions with a number small number of students, with the aim being to create a small-scale version of a learning ecology so that it can be studied in depth and detail (Steffe & Thompson, 2000).
Classroom Experiments	Involves whole classroom experiments where the researcher(s) collaborates with a teacher to assume responsibility for instruction (Cobb, 2000; Confrey & Lachance, 2000; Gravemeijer, 1994).
Pre-Service Teacher Experiments	Involves experiments in which a researcher(s) helps organise and study the education of prospective teachers (Simon, 2000).
In-Service Teacher experiments	Involves experiments in which the researcher(s) collaborates with teachers to support the development of artefacts (Lehrer & Schauble, 2002; Stein, Silver, & Smith, 1998).
School And School District Restructuring Experiments	Involves experiments in which the researcher(s) collaborates with teachers, school administrators, and other stake holders to support organisational change (Confrey, Bell, & Carrejo, 2001).

Table 3-1 illustrates that development research can and has been used in a wide variety of educational settings. Some of these settings involve investigations that utilize in-service teachers, much in the same way that this research project does.

While this type of methodological approach is not necessarily that different from those in other research approaches, van den Akker (1999) does point out some of the disparities between the philosophical frameworks and goals of development research and that of more traditional approaches. Such disparities include the interaction between practitioners and researchers and the way knowledge is gained. In development research there is continual interaction between practitioners and researchers throughout the entire research process. Van den Akker believes that this is needed to gradually clarify both the problem at stake and the characteristics of its potential solution. Also in development research knowledge is gained in the form of design principles. These design principles however are not the sole outcome of the development research process. A fundamental tenet of this type of research is “the dedication to providing direct benefits to all stakeholders within the context of the research” (Reeves, 2000, p. 10).

Reeves (2000) also provides further support for the use of development research in applied contexts given its iterative, continual approach, rather than the linear approach of traditional empirical research. Reeves summed up these differences in his illustration, shown in Figure 3-1.

Please see print copy for Figure 3.1

Figure 3-1 Differences between empirical and development approaches to research as explained by Reeves (2000)

Figure 3-1 clearly illustrates that there are four different and distinct stages in both empirical and development research. The key assumption of empirical research is that practitioners will apply the theory. Reeves and Hedberg (2003) speculate that this assumption is misplaced, especially in education research where persistent, significant problems are present. They claim that this problem is addressed by the continuing cyclic nature at all levels that development research offers. It is this cyclic nature that not only allows for practitioners to be more directly engaged in the conduct of the research, but it also allows for the continual collaboration between practitioners, researchers and technologists.

Research Procedures

The research methodology for the study was guided by the principles of development research outlined by van den Akker (1999) and further developed and modelled by Reeves (2000). In order to accommodate the cyclic nature of development research, the project was conducted in 6 stages.

Stage 1 involved an initial <u>needs analysis</u> to identify what issues practitioners (i.e., K-12 teachers) face when they attempt to combine learning objects with learning designs to create a meaningful educational experience for their students. Data for the needs analysis was gathered during and subsequent to a series of four 2-hour workshop sessions in which participants created WebQuests (i.e., learning designs) incorporating electronic resources (i.e., learning objects). This data was then used then <u>create a series of design principles</u> to guide Stage 2 of the research.

Stage 2 involved <u>the development of a prototype EPSS</u> designed to support teachers as they attempt to combine learning objects with learning designs. The underlying structure of the prototype was based on the guidelines for developing electronic support systems revealed in the previous chapter, as well as the design principles created in Stage 1.

Stage 3 involved <u>evaluating and testing the prototype EPSS</u> as well as <u>continuing the needs analysis</u> and <u>refining the design principles</u>. Data for this Stage was gathered during and after a subsequent series of four 2-hour Workshop sessions in which participants created WebQuests (i.e., learning designs) incorporating electronic resources (i.e., learning objects).

Stage 4 of the research process entailed the <u>design and development of a web-based EPSS</u>. The structure and content of the system was based on analysis of the data leading up to this stage. This stage also involved an expert evaluation, and subsequent modification of the web-based prototype.

Stage 5 involved evaluating and testing the web-based EPSS with teachers who attempted to combine learning objects with learning designs within a one day, 8 hour Workshop setting.

Stage 6 involved the final refinement of the design principles for use by future researchers and developers.

A diagrammatic outline of the research process is shown below in Figure 3-2. This figure also illustrates how the research process for this study relates to Reeves (2000) development research model.

Please see print copy for Figure 3.2

Figure 3-2 An outline of how Reeves' (2000) Development Research model provided a base for the methodology used in this study

Stage 1: Needs Analysis and the Creation of Design Principles

The purpose of Stage 1 was to conduct an initial needs analysis to identify what issues practitioners (i.e., K-12 teachers) face, as they combine learning objects with learning designs and create a series of design principles aimed at addressing these issues.

As teachers design and develop lessons at different times, and often at home, in order to understand the design process a workshop setting was selected for this study. The workshop setting enabled the environment to be controlled therefore reducing the impact of external variables on the study. The setting also allowed the researcher and an assistant to observe all the participants in one location, thus reducing the time and cost of the study.

Participant Recruitment

The participants for Stage 1 were recruited via an advertisement (see Appendix A) inviting teachers to participate in a professional development WebQuest workshop and the associated research project. The workshop was aimed towards teachers who were interested in receiving training in using the Internet to develop WebQuests. The advertisement was sent by facsimile to schools in the Illawarra region of New South Wales in Australia, and resulted in 13 teachers volunteering to participate. This convenient sample (Gall, Borg, & Gall, 1996) was only used in the first Stage of the study.

Workshop Description

Workshop 1 was organised into a series of four 2-hour sessions. The workshop sessions were designed by a team of academics from the Faculty of Education at the University of Wollongong and the researcher. The academics in the team had experience developing both learning designs and learning objects, designing interactive multimedia packages for the K-12 educational setting, and designing and delivering pre-service and in-service teacher training in the area of information and communication technologies for education. One member of the team had particular expertise in visual literacy and visual design. The academic team members facilitated the workshop sessions and the researcher acted in the role of “observer as participant” (Gold, 1969), where the researcher was overtly known to the participants and gave assistance if needed.

The workshop aimed to introduce the participants to the concept and skills of combining learning objects with learning designs (i.e., WebQuests) to create a unit of work on a topic of their choice. Table 3-2 outlines the content of the workshop, while a full description of each session can be found in Appendix B.

Table 3-2 Outline of Workshop

Session	Content
1	• Introduction to web design and learning objects • Developing an outline of learning designs
2	• The visual design of web pages • The structure of learning designs (WebQuest)
3	• Development of learning designs (WebQuest)
4	• Continual development of learning designs (WebQuest)

As the participants were teachers, the workshop sessions were held after school on consecutive Tuesdays. The workshop sessions were held in a computer laboratory at the University of Wollongong. The laboratory was arranged with computers around the perimeter of the room, with a large table suitable for group discussions and planning in the middle.

While the primary purpose of this stage of the research was to conduct a needs analysis, some initial supports were anticipated by the researcher. These supports were provided via a website (see Appendix C) and were designed to give the participants information, help, and guidance. The provided website included hyperlinks to exemplary learning designs (i.e., WebQuests as indentified by Dodge, 2003) such that the participants could observe and explore excellent working examples. The website also included hyperlinks to a number of external sites relating to WebQuests and how to create them. These sites were given to supply the participants with extra information about the design process of WebQuests, including a step by step method on how to construct a WebQuest. The final section of the supporting website included hyperlinks to learning object repositories. The purpose of this section was to direct the participants towards the repositories' search engines so that they could search the metadata of the learning objects in the repository, therefore finding appropriate learning resources for their WebQuest development. An overview of the supporting website including a description of the given supports can be seen in Table 3-3.

Table 3-3 Workshop supports supplied via a supporting website

Supports	Description
Examples of Exemplary WebQuests	Roller Coaster Madness (Adamez & McDonald, 2001); In this WebQuest teams of students are required to locate the best environmental location for the newest and fastest roller coaster ever. Planet WebQuest (Gunning & Thomson, n.d.); This WebQuest requires students to research a planet in the solar system, as they as future astronauts are on a mission to travel there. The Ocean's in Trouble (Ingrum, 2001); In this colourful WebQuests students have to search the Internet to look for relationships between people, marine animals, and the polluted ocean. What does it mean to be Australian (Kerr, 2002). This WebQuest looks at the diverse cultures that make up the Australian population. Students have to use the Internet to answer set questions about the topic.
Helpful Links	The WebQuest Page – a site specifically designed to help those who are using WebQuests (Dodge, 2006). The WebQuest Design Process – a site used and developed by Tom March, a cofounders of the WebQuest model (March, 2003). Building Blocks of a WebQuest – a site that steps users through the main attributes of WebQuests (Anon., 2003)
Learning Object Repositories	EdNA On-line is a service that aims to support and promote the benefits of the Internet for learning, education and training in Australia. It is organized around Australian curriculum and contains over 29,000 learning objects (Education Network Australia, 2005). Multimedia Educational Resource for Learning and On-line Teaching (MERLOT) is a free and open learning object repository based in North America that is designed for educational staff and their students. It contains over 14,000 peer reviewed learning objects (Multimedia Educational Resource for Learning and Online Teaching, 2005).

One notable omission from this supporting website is a link to the learning objects developed by The Learning Federation (2003a). This admission is due to the fact that most of their learning objects were not freely available at the time of the research.

The other supports shown in Table 3-3 were given to the participants not only for guidance and direction, but also as an initial starting point for answering the third research question:

> *How do systems and supports address the issues teachers face as they combine learning objects with learning designs?*

Data Collection

Given the in-depth nature and the complexity of a needs analysis, a variety of data collection techniques were used. One of the main advantages of using this multi-method approach to data collection is corroboration or triangulation (Eisner, 1997; Guba, 1981; LeCompte & Goetz, 1984; Miles & Huberman, 1994; Tashakkori & Teddlie, 1998; Wallen & Fraenkel, 2001). Triangulation helped to validate both the data and the results by combining a range of data sources. This added to the robustness of the study.

The data sources for the needs analysis comprised of:

- A General Information Questionnaire;
- Field Notes;
- Resource Sheets;
- Interviews; and,
- Evaluations of the participants' constructed WebQuests.

A description and rationale for the inclusion of each technique used is given below:

General Information Questionnaire (GIQ)

An instrument entitled 'General Information Questionnaire" was developed specifically for this study and was used to collect basic information to profile the participants.

Questions related to gender, teaching expertise, and previous experience using computers. A copy of this questionnaire can be found in Appendix D.

Field Notes

A main source of collecting data during the actual Workshop was through observation. Gold (1969) identified four different roles that an observer can take while conducting research, ranging from the observer being a complete participant, taking notes covertly, though to the observer being a complete observer and not participating in any activities (see Figure 3-3).

Please see print copy for Figure 3.3

Figure 3-3 The 4 Roles an Observer can take while collecting data (Gold 1969)

During the needs analysis of this study, the researcher assumed the role of ‘participant as observer’, where the researcher was identified to the group, and fully participated with the group. Kemmis and McTaggart (2000) suggest that while such participation creates issues related to validity, it allows for more insight into the process the participants go through. To address this issue of validity a research assistant, who also assumed the role of ‘participant as observer’ was used. Having a second set of field notes allowed for comparisons to be made prior to analysis (i.e., corroboration of observations) and thus ultimately ensuring a more robust result.

While the nature of the observation was largely unstructured the focus was on identifying the issues that the participants faced as they attempted to combine learning objects with learning designs. This was achieved by the observers concentrating on the processes the participants engaged in; the communication between the participants, the instructors and the researchers; and the actions taken by the participants during the study.

Resource Sheets

Resource sheets were also handed out to the participants. The purpose of these sheets was to help identify what resources the participants used in developing their learning design, how the participants found those resources, and what made the participants select those particular resources. These completed resource sheets were collected back by the researcher, and the information collated and analysed. A copy of the resources sheet entitled "WebQuests and Resources" can be found in Appendix E.

Interviews

In order to consolidate the information gained from observing the participants during the workshop and to provide corroboration of the data from other sources, interviews were conducted on a randomly selected sample of the participants (n=5).

Patton (2002) described the usefulness of interviewing by stating that.

> "We interview people to find out from them those things we cannot directly observe. The issue is not whether observational data is more desirable, valid or meaningful than self-report data. The fact of the matter is that we cannot observe everything. We cannot observe feelings thoughts and intentions. We cannot observe behaviours that took place at some previous point in time. We cannot observe situations that preclude the presence of an observer. We cannot observe how people have organised the world and the meanings they attach to what goes on in the world. We have to ask people questions about those things" (p. 278).

The interviews in this study followed a semi-structured guide (see Appendix F), and were aimed at exploring issues related to the research questions. As suggested by Minichiello, Aroni, Timewell, & Alexander (1995) the structure of the interview also allows enough flexibility for participants to express a range of individual perceptions regarding their experiences. Specifically the interview guide raised issues pertaining to:

- The design process they went through when constructing their learning design;
- How they selected digital resources; and,

- The issues they faced when they tried to combine learning objects with learning designs.

At the beginning of the interview the participants were asked if they had any objections to having the interview recorded. They were advised that their comments would be recorded anonymously, and they would not be identified individually. All of the participants agreed to the recording process, thus all interviews were recorded ensuring an accurate record was obtained. As recommended by Minichiello et al., (1995) the interview recordings were transcribed verbatim at the end of interview process. In cases where participants referred to other colleagues by name, the colleague's name was changed. To verify the accuracy of the researcher's interpretation of the data collected a process of 'member checking' (Miles & Huberman, 1994) was undertaken where each interviewee was asked to listen to his/her individual audio recording and review the transcription for accuracy.

WebQuest Evaluations

The participants' WebQuests were evaluated at the completion of the Workshop by the researcher and two external evaluators. The external evaluators were both academics with expertise in the development and evaluation of learning designs for educational purposes. Both external evaluators agreed to participate on a voluntary basis. Both the researcher and the two external evaluators reviewed the participants' WebQuests using the WebQuest Evaluation Rubric. This rubric was designed by Bellofatto, Bohl, Casey, Krill, and Dodge (2001) and comprises of items associated with the overall aesthetics of the WebQuest, as well as the introduction, task, process, resources and evaluation attributes of WebQuests (see Appendix G). While the instrument is widely used by professionals across the education sector, little research has been conducted into the validity and reliability of the instrument. To ensure the robustness of this aspect of the research these problems of validity and reliability needed to be addressed.

The WebQuest Evaluation Rubric was tested for content validity and both test-retest and inter-observer reliability. Carmines and Zeller (1979) describe these tests as:

Content Validity	Refers to the extent to which an instrument actually measures what it alleges to measure.

Test-Retest Reliability	Refers to the instrument's consistency among different administrations
Inter-Observer Reliability	Refers to the instrument's consistency among different observers.

Participants in the validity and reliability testing process were asked, and agreed, to participate in the study on a voluntary basis, thus satisfying the Human Research Ethics Policy of the University of Wollongong (see Appendix H).

To examine content validity, a panel of three experts (see Appendix I) in the area of learning designs were asked to inspect the WebQuest Evaluation Rubric to see if the instrument items cover the content the tool purports to measure. The panel of experts were satisfied that the criteria for content validity were met and no changes to the instrument were required.

The WebQuest Evaluation Rubric was then trialled with a group of practitioners (in this instance a group of second-year pre-service teachers) (n=42) to establish inter-observer reliability as well as test-retest reliability. The retest was held two weeks after the original test. Data pertaining to the reliability testing was entered into a spreadsheet file and subsequently transferred for storage and analysis into a Statistical Package for the Social Sciences (SPSS). A series of tests were then performed on the data.

Test-retest reliability was calculated using interclass correlation coefficient (ICC). The ICC for each section of the Web Quest Evaluation Rubric and the total instrument are displayed in Table 3-4.

Table 3-4 Measures of Reliability of the WebQuest Evaluation Rubric

Instrument Section	ICC
Overall Aesthetics	0.72
Introduction	0.71
Task	0.75
Process	0.74
Resources	0.71
Evaluation	0.76
Total	**0.81**

Table 3-4 points out that the ICCs for each section of the Web Evaluation Rubric exceeds 0.70. This indicates that the Rubric is a reliable instrument to evaluate WebQuests.

The internal consistency of the instrument was calculated using coefficient alpha. The reliability coefficient was 0.71 which exceeds the minimum value of 0.70 recommended by Nunnally (1978). This further indicates that the Rubric is a reliable instrument in evaluating WebQuests.

The final aspect of Stage 1 involved the production of a series of Design Principles.

Design Principles

The purpose of deriving a series of design principles from the collected data was to inform the following stage of the research. The design principles took the form of Heuristics. Heuristics are single sentence ‘rules of thumb’ designed to link theoretical concepts (or the findings from robust data collection techniques in this case) to the realities of information technology development (Haney, Lange, & Barson, 1968; Hoban, Heider, & Stoner, 1981). The accepted format of a heuristic statement is a single active sentence, followed by a short explanation in support of the statement.

Stage 2: The Development of a Prototype EPSS

The second stage of the research involved developing a prototype EPSS designed to support teachers as they attempted to combine learning objects with learning designs.

The fundamental layout and construction of the prototype EPSS was based on two main sources. The first source came from *The Guidelines for Developing a Cognitive Tool in the Form of an EPSS.* These guidelines were identified in the previous chapter where they were derived from an in-depth literature review on the development of cognitive tools, and more specifically development of EPSS. The second source of information for the construction of the prototype EPSS came from the design principles created after the needs analysis conducted during Stage 1 of this research. The combination of these two sources allowed for the development of a prototype EPSS that has its foundations steeped in research and its focus specific for the needs of the participants in the study.

Stage 3: Evaluating the Prototype EPSS, Continuing the Needs Analysis and Refining the Design Principles

Stage 3 of the research involved three distinct phases, two of which took place concurrently during and one after the second series of four 2-hour workshops. An overview of this process can be seen in Figure 3-4.

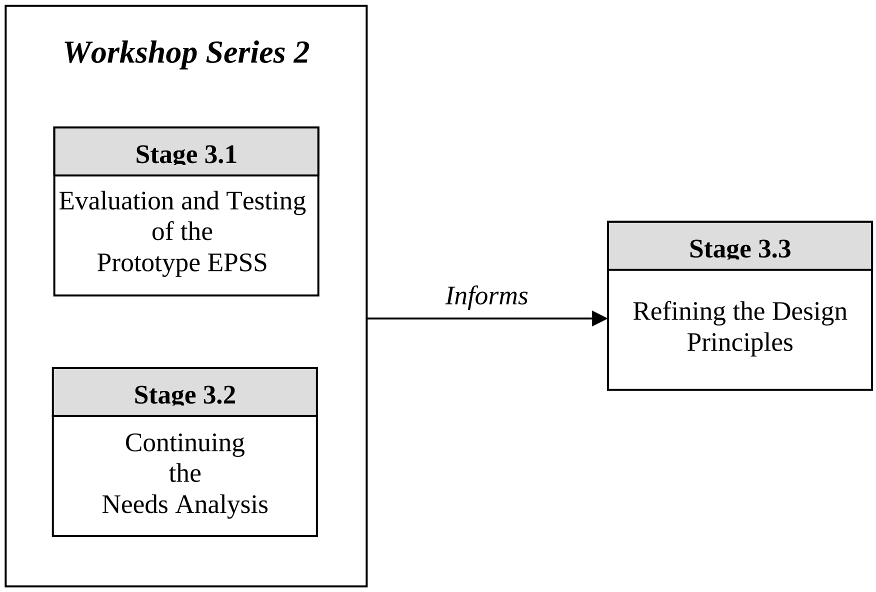

Figure 3-4 An Overview of Stage 3 of the Research Project

Stage 3.1 involved evaluating and testing the prototype EPSS, while the Stage 3.2 involved continuing the needs analysis commenced in Stage 1. The final phase of this Stage of the research involved refining design principles to aid in the development of the web-based EPSS in the next stage of the research

Participant Recruitment

As in Stage 1, participants were recruited via an advertisement, inviting teachers to participate in a professional development workshop focusing on developing WebQuests. The advertisement was again sent to schools in the Illawarra region of New South Wales, Australia. This advertisement resulted in 12 teachers volunteering to participate.

Workshop Description

To ensure reliability, the Stage 3 workshop was conducted in a similar format to that in Stage 1 with the only difference being the inclusion of the prototype EPSS to scaffold the process. The participants were given the prototype at the start of the workshop and were instructed to refer to the model during the design and development periods of the workshop.

Data Collection

Data was also collected using the same sources outlined in Stage 1 (i.e., A General Information Questionnaire; Field Notes; Resource Sheets; Interviews; and, WebQuest Evaluations).

However the interview structure was modified slightly to accommodate the participants perceptions of the usefulness of the prototype EPSS (see Appendix F). These modifications included the addition of three extra questions all relating directly to the participants use of the paper-based prototype.

Design Principles

Stage 3 also involved refining the design principles creating in Stage 1, the purpose of which was to inform the following stage - Stage 4.

Stage 4: Design and Development of a Web-Based EPSS

This stage of the research study involved the 3 step development of a web-based EPSS designed to support teachers as they combine learning objects with learning designs. An overview of the 3 steps can be seen in Figure 3-5.

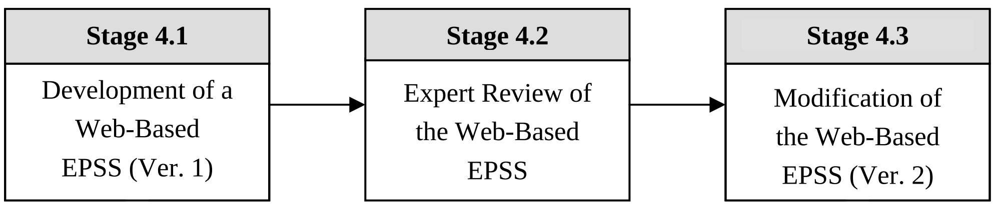

Figure 3-5 An Overview of Stage 4 of the Research Project

The first step, Stage 4.1, involved the design and the initial development of the EPSS based on the heuristic statements derived from Stages 1 and 3 of the research project.

The second step, Stage 4.2, involved an expert review of the EPSS. Expert reviews are one of the most commonly used approached to internal validation (Richey, 2005). They are a type of formative evaluation that can provide information about the workability and relevancy of a project. Expert reviews have been described as the “life blood” of the development process (Reeves & Hedberg, 2003) as they have the ability to provide feedback, not only about whether a developed system meets its objectives, but also they provide a form of quality control (Clark, 1995).

Richey (2005) suggests that the soundness of the expert review depends upon the number of reviewers and the authority of the reviewers. In this study five professionals (see Appendix J), with expertise ranging from experienced project managers in instructional design to lecturers and an Associate Professor in Information Technology, were asked to review the EPSS in terms of its structure, quality and depth, as well as the ability of the prototype to guide teachers through the process of combining learning objects with learning designs. The expert reviewers were asked to complete a review sheet (see Appendix K) as they evaluated the system. The purpose of the expert review was not only to find any problems in the EPSS, but also to seek any recommendations for improvement from the experts, therefore enabling a more rigorous support system to be developed.

The third and final step of this stage of the research involved the modification and refinement of the EPSS based on the information gathered from the expert review.

Stage 5: Evaluation and Testing the Web-Based EPSS

Stage 5 of the research involved evaluating and testing the web-based EPSS. This stage comprised of a workshop which was conducted within the program of the 2004 Innovative Technology Schools Conference (ITSC). The conference hosted by Apple™ and held at the University of Wollongong, in NSW, Australia aimed at providing professional development for educators from around the Asia-Pacific region.

Participant Recruitment

Stage 5 participants were recruited in a similar fashion to stages 1 and 3. However this time the professional development workshop was not only advertised locally, but also nationally, through the ITSC advertisements and publications. This combined effort resulted in 16 teachers attending the workshop.

Workshop Description

In order in ensure reliability, the workshop content, format, and data collection techniques were kept the same as the previous two workshops. Although rather than the Workshop running over four consecutive weeks, the workshop was conducted on a single day with meal breaks between each 2-hour session. This change was necessary to fit into the schedule of the conference. The only other difference in the workshop was that the participants were able the use the web-based prototype. The prototype was introduced at the start of the workshop, and the participants were encouraged to use it.

Data Collection

Once again the General Information Questionnaire, field notes, resources sheets and interviews were used to collect data. The only difference being the interview structure, which was changed once again to accommodate questions around the developed web-based, EPSS (see Appendix F).

Stage 6: The Final Refinement of the Design Principles

The final stage of the research involved analysing the entire data collected during the project, as well as reviewing the methodology used during each Stage of the project. Using the information derived from this, a series of design principles were constructed. The purpose of these design principles was to provide aid to future researchers and developers as they set out to conduct further researcher in this area.

Overview of Data Collection Techniques

The cyclic nature of development research made data collection in this study a complex issue. To ensure the robustness of the research, rigorous uniform data collection techniques were needed. An overview of the data collection techniques used in this research study can be seen in Table 3-5.

Table 3-5 Overview of the Data Collection Techniques used in this Research Study

Stages		Data Collection Techniques Used					
		GIQ	Field Notes	Resources Sheets	WebQuest Evaluation	Interviews	Review Sheet
Stage 1	Needs Analysis and Creation of Design Principles	✓	✓	✓	✓	✓	
Stage 2	The Development of a Prototype EPSS						
Stage 3	Evaluating the Prototype EPSS, continuing the needs analysis and refining the Design Principles	✓	✓	✓	✓	✓ Modified	
Stage 4	Development of the web-based EPSS						
	Expert review of the web-based EPSS					✓	✓
	Modification of the web-based EPSS						
Stage 5	Evaluation and testing of the web-based EPSS	✓	✓	✓	✓	✓ Modified	
Stage 6	The final refinement of the Design Principles		✓	✓	✓	✓	✓

As evident from the above table the data collection techniques were the same for each workshop, apart from a slight modification to the structure of the interview. This was necessary in both cases to accommodate the paper-based and web-based systems. This uniform and consistent approach across the workshops enabled comparisons to be made between them.

Method of Analysis

The data collected during this research project was analysed in two different ways depending on the nature of the data gathered. The methods of analysis for both the quantitative and qualitative data collected are described below.

Quantitative Data

The quantitative data associated with the General Information Questionnaire was coded to enable computerised entry. The Data was then entered into a spreadsheet file and subsequently transferred for storage and analysis in Statistical Package for the Social Sciences (SPSS). Descriptive statistics were then calculated for the data which provided a profile of the participants. A series of one way Analysis of Variances (ANOVA's) and Chi-Square tests were also performed on the data to determine if there were any significant differences between the three Workshop groups.

Qualitative Data

The process of analysing the data collected from the field notes, interviews, resource sheets, WebQuest evaluations and expert reviews followed the techniques of analysis recommended by Miles and Huberman (1994), and McCracken (1988).

The analysis involved transcribing the data before coding individual comments into categories determined by the research questions. Each category was then sub-coded and investigated in more detail. This method enabled issues and themes in the data to emerge and, from these issues and themes, conclusions were able to be made. The process of coding the data in this project is summarised below in Table 3-6, together with the processes put forward by McCracken and Miles and Huberman, as well as the computer software used.

Table 3-6 Stages of Computer Aided Data Analysis undertaken in this Study

Description of process used to analyse data	Miles & Huberman's (1994) Stages	McCracken's (1988) Stage	Software used
Transcribing: Interview, field notes and expert reviews transcribed			Microsoft Word
Coding: Individual comments coded according to categories determined by the research question	*Data reduction:* Selection, focusing, simplifying, abstracting and transforming the data.	*Stage 1:* Judgment of individual utterances with little concern for their larger significance	NVivo
Sub-Coding: Each category used in the coding process was investigated in more detail to reveal the issues which emerge		*Stage 2:* Meta-observations. Where implications and possibilities of the data are examined in more detail.	NVivo
Ordering and Displaying: Issues were determined, and generalisations made	*Data display:* Creation of organized, compressed assembly of information that permits conclusion drawing and action.	*Stage 3*: Observations are developed in relation to other observations.	Microsoft Word
Conclusion Drawing: Conclusions were made and written up for inclusion in this thesis	*Conclusion drawing and verification:* Decisions about the meaning of data and testing validity of findings (pp 10-11).	*Stage 4:* Judgment of data and analysis, and identification of themes and their interrelationships.	Microsoft Word
Verifying: Conclusions were verified by referring back to original data		*Stage 5:* Review of the stage four conclusions (pp. 44-46)	

The success of the coding process above required the development of an in-depth coding framework. The basic structure of the framework came from the three research sub-questions. Then as issues emerged in the data, sub-codes were developed and added. A version of the initial coding framework for this research project can be seen below in Table 3-7.

Table 3-7 Coding framework for the qualitative data used in the study.

Question 1 What are the issues that teachers face as they combine learning objects with learning designs?		
Coding	Sub-Coding	
• Issues teachers faced	Sub-coding themes to be derived if trends appear in the data	
Question 2 What design principles guide the development of systems and supports which assist teachers as they combine learning objects with learning designs?		
Coding	Sub-Coding	
• Issues relating to individual Design Principles	Sub-coding themes to be derived if trends appear in the data.	
Question 3 How do systems and supports address the issues teachers face as they combine learning objects with learning designs?		
Coding	Sub-Coding	
• Initial Supporting Website	Strengths	Any reported strengths of the initial supporting website.
	Weaknesses	Any reported weaknesses of the initial supporting website.
• Paper-based prototype	Strengths	Any reported strengths of the paper-based prototype.
	Weaknesses	Any reported weaknesses of the paper-based prototype.
• Web-Based Prototype	Strengths	Any reported strengths of the web-based prototype.
	Weaknesses	Any reported weaknesses of the web-based prototype.

Transcripts of field notes, interviews, resource sheets, and expert reviews were coded based on the framework above, with the final coding undertaken by the researcher and an independent coder who was engaged in the analysing process to ensure inter-coder reliability. Consistency in coding occurred in 96.5% on the cases (i.e., coding of individual units of text across all qualitative sources of data), with the main differences in coding occurred in the interpretation of comments.

The WebQuests the participants designed and constructed were also analysed by the researcher. This analysis was compared to the findings from the quantitative data, collected by the external evaluations of the participants WebQuests, and the analysis of the qualitative data.

Ethical Considerations

This study was conducted using the ethical guidelines implemented by the University of Wollongong (2004). It was important for the research to follow these strict ethical guidelines in order to protect the rights of participants, and ensure that the research was conducted in a fair and equitable manner. Approval was also required by the University's Ethics Committee, who monitor all research conducted within the University using human or animal subjects (see Appendix H). The sections below describe how ethical issues in the conduct of the research have been addressed.

Informed Consent

All of the participants in this study were informed of the nature and extent of the research prior to its commencement. Eisner (1997) suggests that in qualitative research it is sometimes difficult to inform participants accurately about the outcomes of the research, as this is often not known, except in the most general terms:

> "We all like the idea of informed consent, but we are less sure just who is to provide that consent, just how much consent is needed, and how we can inform others so as to obtain consent when we have such a hard time predicting what we need to get consent about" (p. 215).

Nevertheless, an attempt was made to provide clear information to participants, particularly about their own roles in the research. All participants were required to sign an agreement to participate which provided full details of the aims and focus of the research (see Appendix L).

Confidentiality of Records

During the research all participants were given a pseudonym, which bore no resemblance to their own name. Access to the recorded interviews and audiotapes was confined to the researcher and transcribers. Audiotapes, transcripts and all other records were stored securely in the researcher's office. It is intended to retain transcripts for five years in secure storage.

Possible Risks to Participants

There were no apparent risks to participants in the study. The Workshops were conducted outside normal working hours, and the participants were provided with appropriate refreshments. All participants had the option of withdrawing at any time.

Payment for Participation

Participants were not offered any incentive payment to be part of the research. They all freely agreed to take part without recompense.

Ensuring Validity and Reliability

Ensuring for validity and reliability is a fundamental requirement of any research (Campbell & Stanley, 1966). However, a number of researchers have commented on the difficulty of ensuring the validity and reliability of the instruments used in this type of research (Eisner, 1997; Wallen & Fraenkel, 2001). Nevertheless, it was important to ensure that some confidence could be placed in the findings of the current research by attending to the validity and reliability of the research procedures.

A number of techniques and measures have been discussed throughout this chapter to ensure that the validity and reliability of the methodology used, inferences made, and conclusions drawn from this research study are not only appropriate, but also consistent over time. A summary of these procedures can be seen below in Table 3-8.

Table 3-8 Procedures to Ensure Validity in the Project

Procedure	Implementation
Use of structural corroboration, by the use of multiple sources of data (Eisner, 1997; Guba, 1981; LeCompte & Goetz, 1984; Miles & Huberman, 1994; Tashakkori & Teddlie, 1998; Wallen & Fraenkel, 2001).	Triangulation of data sources, (field notes, resource sheets and interviews).
Collection of referential materials, e.g., documents, audio recordings and other 'slice-of-life' data items against which findings can be tested (Eisner, 1997; Guba, 1981; Wallen & Fraenkel, 2001).	Field notes of participations using the learning objects, interviews, audio recordings and resource sheets.
Consensual validation, or agreement among other researchers that the description and interpretation of the research are right (Eisner, 1997; Guba, 1981; LeCompte & Goetz, 1984).	Formal review of research proposal at a public forum as part of University PhD requirements.
Checking for researcher effects (LeCompte & Goetz, 1984; Miles & Huberman, 1994; Wallen & Fraenkel, 2001).	Low profile adopted by researcher; data collection was as unobtrusive as possible (some researcher effect may have occurred, however, and this is discussed in the *Limitations of the Research* in Chapter 5).
Obtaining confirmatory feedback from the informants themselves (Guba, 1981; Miles & Huberman, 1994).	Particularly in the follow-up interviews, participants were asked to identify what problems they had.

Combining the validity and reliability procedures shown in Table 3-8 has increased the reliability and validity of the study, adding to the robustness of the research.

Conclusion

This chapter has described the methods used to collect data which can help to provide answers to the research questions of the study. Data from all sources—the questionnaires, the field notes, the post Workshop interviews, and other documentary evidence and notes—were analysed using techniques of analysis recommended by Miles and Huberman (1994), and McCracken (1988) The analyses of this data, together with a discussion of the findings are given in the next two chapters.

CHAPTER 4

Results and Discussion

Introduction

This chapter presents the results of all six stages of the study through the analysis of the qualitative and quantitative data relevant to the research questions:

1. *What are the issues that teachers face as they combine learning objects with learning designs?*
2. *What design principles guide the development of systems and supports which assist teachers as they combine learning objects with learning designs?*
3. *How do systems and supports address the issues teachers face as they combine learning objects with learning designs?*

Data collected for Stage 1 was analysed to obtain a clear understanding of the needs of the participants as they attempted to combine learning objects with learning designs. Using the findings from this analysis and existing empirical evidence a series of design principles aimed at guiding the development of an EPSS were constructed. In Stage 2, these design principles formed the framework for the actual development of a prototype EPSS. Stage 3 involved an analysis of the data collected during the evaluation and testing of the prototype EPSS. The same data was also used to refine the needs analysis and subsequently the refinement of the design principles. In Stage 4, a web-based EPSS was developed based on refined design principles. This Stage also involved an expert evaluation of the web-based EPSS, followed by subsequent modifications. Stage 5 of the research entailed an analysis of the data collected during the testing of the EPSS while the sixth and final stage presents the final design principles generated by this research.

This chapter begins with a profile of the participants involved in the research project, followed by a detailed analysis of the data related to each stage of the study.

Participant Profile

The cyclic nature of this development research project required volunteer participants in Stages 1, 3 and 5 of the study. Using methods of convenient sampling (Gall et al., 1996), the study involved 41 participants in total. There were 13 participants in Stage 1; 12 in Stage 3 and 16 participants in Stage 5. Each set of participants were independent, with the variation in numbers of participants in each stage being due to the voluntary nature of the workshops.

All 41 participants completed the General Information Questionnaire (GIQ) at the start of their involvement in the study. This questionnaire (see Appendix D) was used to profile the participants' background in teaching and computer usage.

The participants ranged in age from 23 to 59 with a mean age of 43. The mean age of the teaching population across Australia is also 43 (Australian Bureau of Statistics, 2005). They ranged in teaching experience from less than a year to more than 39 years, with a ratio of 12 males to 29 females, which was also representative of the Australia teaching population, where 68% of teachers are female (Australian Bureau of Statistics, 2005). The majority of the participants taught in primary schools (n=29) while the remaining 12 were secondary school teachers. A full break down of the demographic profile of the participants can be seen in Table 4-1:

Table 4-1 Descriptive statistics about the participants

		Stage 1 *Needs Analysis*	**Stage 3** *Evaluating and testing the Prototype EPSS*	**Stage 5** *Evaluating and Testing the Web-Based EPSS*
Total Participants		13	12	16
Gender	Male	3	3	9
	Female	10	9	7
Average Age [a]		46.3 (8.3)	44.6 (10.1)	41.1 (11.4)
Average Years Teaching [a]		17.9 (8.3)	16.8 (10.9)	16.5 (11.0)
Area of Teaching	Primary	11	8	8
	Secondary	2	4	8

[a] values are mean (± SD)

With respect to the computer usage of the participants, 90% (n=38) indicated that they were either comfortable or very comfortable at using a computer. Given that learning objects are web accessible and the premise of this study investigated the use of a learning design framework, that is a WebQuest, as a way of using learning objects, it was important to get a sense of participants' previous experience developing web pages. All of the participants (n=41) indicated that they had a beginner or intermediate level of experience in developing web pages. None reported that they had advanced skills in this area. A full break down of participant comfort levels when using a computer and their level of experience in developing web pages can be seen in Table 4-2.

Table 4-2 Participants' responses to question 6 and 7 of the GIQ

		Number of Responses			
		Uncomfortable	Slightly Comfortable	Comfortable	Very Comfortable
Question 6 Participants' comfort level when using a computer	Stage 1	0	0	7	6
	Stage 3	0	3	3	6
	Stage 5	0	1	6	9
Question 7 Participants' experience in developing web pages		Never	Beginner	Intermediate	Advanced
	Stage 1	0	5	8	0
	Stage 3	0	5	7	0
	Stage 5	0	6	10	0

To further understand participants' web development skills, the GIQ also asked them to identify the computer software programs that they had used to create web pages. Dreamweaver (n=16) and Claris Homepage (n=17) were the most prevalent programs used by participants. The majority of the participants (n=28) also reported that they used computers in their teaching. Most of the participants (n=28) also reported that they encouraged their students to use a computer to complete assignments or projects.

To understand participants' previous experience using learning objects the GIQ asked: *Do you use electronic resources (CD-ROMs, the Internet) in your teaching?* All forty one of the participants responded that they do use some sort electronic resource in their teaching. Most of the participants (n=29) also responded to the subsequent open-ended question which asked the participants how they used electronic resources in their teaching. The responses from these 29 participants were then categorised and two main themes emerged suggesting that the participants used electronic resources for: 1) researching information and, 2) for multimedia presentations. A breakdown of the types of computer resources the participants used in their teaching can be seen in Table 4-3.

Table 4-3 How the participants were using computer based resources prior to the study

General Theme of Responses	Number of Responses	Sample of Responses
Research Information	23	I use CD-ROMS to look for information
		I use the Internet to research information
		Search engines for information
Multimedia Presentations	8	To make mind maps to record students findings
		I use PowerPoint for class presentations
Miscellaneous	8	To play games
		To Watch DVDs

(N.B. Participants could select more than one method)

The information presented in Table 4-3 is similar to the results of a large international study (Kozma, 2003) which examined the findings of 174 case studies that involved the use of technology in the classroom. Kozma's study revealed that, like this study, the majority of teachers from over 28 countries (including Australia) mainly used technology in their teaching to search for information (77%) or present information using multimedia software (52%). These comparisons are important as they suggest that the teachers who participated in this study were representative of other teachers, therefore indicating that the findings of this study may be applicable to a wider range of teachers.

The final open-ended question of the GIQ asked the participants what they hoped to achieve by partaking in the workshop. The most prevalent answers were:

- To learn about WebQuests (44%);
- To be able to develop web pages (24%); and
- To gain skills in using the web development tool, *Dreamweaver*™ (20%).

This willingness of the participants to gain new skills was important in this study as research has revealed that teachers who approach technology professional development with an attitude that is open to change are more likely to use the technology in their classroom than teachers who attend training with ambivalence (Vannatta & Fordham, 2004).

A series of one-way ANOVA and Chi-Squared tests were performed on the data obtained from the GIQ to determine whether there were any significant differences between the three groups. The results indicated no significant difference ($p = .05$) between the participants in Stages 1, 3 and 5 of the research based on their age, the number of years they have been teaching, their comfort level when using a computer or their expertise in website development. This lack of significant difference allowed for comparisons to be successfully made between the different cohorts. This was an important facet in the study as comparisons between the three stages were an integral part of the methodology.

In summary, the majority of the participants in this study were experienced teachers who were not only comfortable with computer technology, but were also willing to learn how new technologies can be applies to classroom teaching.

Stage 1: Needs Analysis and the Creation of Design Principles

This stage of the research specifically addressed the first two research questions:

1. *What are the issues that teachers face as they combine learning objects with learning designs?*
2. *What design principles guide the development of systems and supports which assist teachers as they combine learning objects with learning designs?*

To answer these questions data collected from the participants' WebQuest evaluations, field notes, resource sheets and post workshop interviews was analysed. An overview of this analysis is presented below and is followed by a detailed discussion of the findings.

Stage 1: Data Analysis

The first type of artefact to be analysed from Stage 1 of the research was the participants' completed WebQuests. These WebQuests were analysed to help identify issues the participants had as they combined learning objects with learning designs. The

WebQuests were also evaluated to enable comparisons to be made between the different stages of the research.

The WebQuests from Stage 1 were collected from the participants at the conclusion of the first series of workshops. A descriptive overview of the WebQuests can be seen in Table 4-4. This overview displays the titles of WebQuests created during the first series of workshops, the age of the students the WebQuests were designed for, a brief description of the WebQuests and, the number of attributes the participant had started to design within the WebQuest.

A notable observation made from the collection of the participants' WebQuests was that out of the 13 participants from Stage 1 only 6 (46%) had completed a WebQuest to a level that could be viewed using a web browser. The remaining seven participants did not develop their WebQuests to this level and therefore could not be evaluated. Out of the six WebQuest that could be evaluated one was designed for secondary food technology classes, four were designed for junior science classes and one for primary history classes.

Table 4-4 A brief description of the WebQuests collected after the first series of workshops

Participant	Description
1	Title: Eat your way to Health Focus: Ages 14 - 15 Description: A WebQuest where year 9 students are required to make an informative brochure about a disease. Level of Completion: 5/5 attributes commenced.
2	Title: The Noisy Insects Focus: Ages 7 - 8 Description: In this WebQuest students in years 3 and 4 are invited to investigate an insect shell found in the school grounds. Level of Completion: 5/5 attributes commenced.
4	Title: The Greenhouse Effect Focus: Not Given Description: A partial completed WebQuest on the Greenhouse Effect in which the task is the only working attribute. Level of Completion: 1/5 attributes commenced.
7	Title: Frogs Focus: Not Given Description: A WebQuest where students have to complete a number of questions sheets on frogs. Level of Completion: 5/5 attributes commenced.
9	Title: Wet and Dry Environments Focus: Ages 7 - 8 Description: A WebQuest aimed at students in years 3 and 4 that focuses on a self selected environmental task. Level of Completion: 5/5 attributes commenced.
12	Title: The History of Dapto Focus: Ages 7 - 8 Description: This WebQuest requires year 3 and 4 students to create a PowerPoint presentation about the local history. Level of Completion: 5/5 attributes commenced.

An example of one of these WebQuests (Participants 1's) can be seen in Figure 4-1. The figure shows four screen shots of the working WebQuest.

Please see print copy for Figure 4.1

Figure 4-1 Four screen shots of Participant 1's WebQuest

These screen shots also reveal that the participant had commenced the introduction, task, process, and evaluation sections of the WebQuest, although the evaluation section contained very little content.

To evaluate the WebQuests from Stage 1, a review of the six WebQuests was initially conducted by the researcher. The full results of this evaluation can be seen in Appendix M, with an example showing the results from Participant 1’s WebQuest evaluation shown in Table 4-5. The table is organised to show how the WebQuest Evaluation Rubric (Bellofatto et al., 2001) criteria was applied to each participants design.

Table 4-5 The researcher evaluation of Participant 1's WebQuest

Please see print copy for Table 4.5

This researcher evaluation of Participant 1's WebQuest revealed that the participant had created a visually appealing WebQuest by using a consistent and appropriate colour and font, and by implementing appropriate and thematic graphics. This can be seen in Figure 4-1, where the graphic in the centre of the top left screen shot specifically relates to the topic of the WebQuest – nutrition. This screen shot also displays the introduction section of Participant 1's WebQuest. The purpose of the introduction is to set the stage and provide background information about the WebQuest (Dodge, 1995). The researcher deemed that Participant 1's introduction achieved this, although not in an engaging way and therefore the participant only received two out of four for that section.

The task that Participant 1 created required users to design a poster to inform people about a disease related to nutrition. This process required students to select and read appropriate information from a given learning object (an informative website) and duplicate it in the brochure. The researcher thought that the cognitive level of this task was achievable, but that it was limited in its significance to student's lives, and therefore evaluated it to be 3 out 6. The researcher evaluated the process to be clear, but considered the structure behind the process to be inadequate for all students to complete the task.

Two independent external evaluators also reviewed this WebQuest and the five other WebQuests from this stage using the same WebQuest Evaluation Rubric (Bellofatto et al., 2001). The evaluators' individual results along with the researcher's results were compared to see if there was a high level of agreement between their assessments. This comparison returned an inter-observer agreement of 81.78% which indicated that there was a high level of agreement between the scores of the three evaluators. The mean scores from the evaluators were calculated for each item on each WebQuest evaluation, with the results shown in Table 4-6.

Table 4-6 The mean scores from three evaluations of the participant's WebQuests in Stage 1 of the research

		Participants					
		1	**2**	**4**	**7**	**9**	**12**
Overall Aesthetics	Visual Appeal /4	4	2	0	3	4	3
	Navigation /4	4	2	0	2	2	3
	Mechanical Aspects /2	1	1	0	1	2	2
	Sub-Total /10	**9**	**5**	**0**	**5**	**8**	**8**
Introduction (Learning Supports)	Motivational Effectiveness /2	2	2	n/c	2	2	2
	Cognitive Effectiveness /2	1	2	n/c	2	2	2
	Sub-Total /4	**3**	**4**	**n/c**	**4**	**4**	**4**
Task (Learning Tasks)	Connection of Tasks to Standards /4	0	0	0	2	2	1
	Cognitive Level of Tasks /6	3	3	1	3	4	6
	Sub-Total /10	**3**	**3**	**1**	**5**	**6**	**7**
Process (Learning Supports)	Clarity of Process /4	4	4	n/c	2	3	4
	Scaffolding of Process /6	3	3	n/c	3	0	3
	Richness of Process /2	0	0	n/c	1	1	1
	Sub-Total /12	**7**	**7**	**n/c**	**6**	**4**	**8**
Resources (Learning Objects)	Relevance & Quantity of Resources /4	2	2	n/c	4	0	2
	Quality of Resources /4	2	2	n/c	2	0	2
	Sub-Total /8	**4**	**4**	**n/c**	**6**	**0**	**4**
Evaluation (Learning Supports)	Clarity of Evaluation /6	**0**	**0**	**n/c**	**0**	**4**	**3**
TOTAL (%) includes only attributes commenced		**52**	**46**	**8**	**52**	**52**	**68**

(N.B. A higher number represents a better result)

n/c = Indicates that the participants did not commence that section

The evaluation of the WebQuests included only the sections of the participants' WebQuests that had been commenced. An example of this was evident with Participant 4 where the evaluation revealed that while Participant 4's WebQuest did have the structure of a WebQuest (i.e., the introduction, task, process, resources and evaluation attributes) only one attribute, the task, was commenced. Thus a large proportion of Participant 4's results included '*n/c*' indicating that the sections were 'not commenced'. The total scores of the participants' WebQuests also reflected this by only including the attributes commenced.

Table 4-6 also reveals that four out of the six Participants achieved an overall total of over 50% for their WebQuests. Further investigation revealed that five of the participants achieved perfect or near perfect marks for their introductions, with the same 5 participants awarded average or above average marks for their overall aesthetics. The evaluation also reveals that the half of the WebQuests achieved average scores for their resources and another half received zero out of six for their evaluation attribute.

Further issues arising from both the researcher and the external evaluations of the WebQuests are discussed later in conjunction with findings from the qualitative data.

The qualitative data comprised of field notes, resource sheets and post workshop interviews from this stage of the research. Individual comments from these data sources were analysed and originally coded into one broad category, 'issues participants faced,' which was determined by the first research question. As the data was investigated in more detail several trends emerged. These trends began to illuminate the issues that the participants faced as they tried to combine learning objects with learning designs. From these trends five main themes surfaced; *Technological Competency, Time Limitations, Resource Collection, Pedagogical Issues, and the use of the Supporting Website.* The number of individual comments relating to each of the themes can be seen in Table 4-7.

Table 4-7 The prevalence of themes derived from the data collected during Stage 1

Major Themes	Sub-Themes	Number of Supporting Comments from the Data			
		Field Notes	Resources Sheets	Interviews	**Total**
1. Technological Competency	Web Development	20	1	6	**27**
	Image Manipulation	13	8	4	**25**
2. Time Limitations		15	9	4	**28**
3. Resource Collection	-	4	11	3	**18**
4. Pedagogical Issues	-	9	-	5	**14**
5. Use of Supporting Website	-	6	3	5	**14**

The table shows that, of the five themes derived from the data, issues relating to the participants' technical competency was the most prevalent issue encountered. This was followed by time limitations faced by the participants, with resource collection, pedagogical issues and issues relating to the supporting website also appearing in significant numbers. The high number of comments relating to technical issues across the various forms of data indicated that further investigation was required and the subsequent examination resulted in two sub-themes emerging: issues with web development tools and issues with image manipulation tools.

A notable observation from Table 4-7 is that three of the themes can be directly related to the components of the WebQuests Evaluations seen in Table 4-6. For example; Overall Aesthetics in the WebQuest Evaluations can be seen to parallel the technological competency theme as it relates to the functionality of the actual website and the visual elements, the Introduction, Task, Process and Evaluation are all pedagogical issues in WebQuests (i.e., learning designs) and finally the Resources (i.e., learning objects) relate directly to issues associated with the resource collection theme. An overview of this connection can be seen in Figure 4-2.

Figure 4-2 An overview indicating how the qualitative and quantitative findings from the initial needs analysis are interconnected

The 5 Themes Derived from the Qualitative Data		Components of the WebQuests evaluated by Quantitative Data
Technological Competency	→	Overall Aesthetics
Resource Collection	→	Resources
Pedagogical Issues	→	Introduction Task Process Evaluation
Time Limitations		-
Use of Supporting Website		-

The two themes shown in Figure 4-2 that do not relate to the components of the WebQuest evaluation are still extremely important in this study as they give an indication of the issues related to the time taken to create a WebQuest and the participants' perceptions of the usefulness of the support given. These observations, the connections shown above and other issues arising from the initial needs analysis are discussed below, in relation to the five themes identified in this section.

Theme 1: Technological Competency

The theme of technological competency refers to all practical computer related difficulties reported either by the two observers through their field notes, the participants in their resources sheets, or by disclosure in the post workshop interviews. Table 4-8 contains an excerpt from Table 4-7, with a 'Total' row included that indicates exactly how prevalent the technical issues were, with over 50 individual comments being made about the technical problems the participants faced as they tried to combine learning objects with learning designs.

Table 4-8 The prevalence of technical issues encountered during the first workshop

Major Themes	Sub-Themes	Number of Supporting Comments from the Data			
		Field Notes	Resources Sheets	Interviews	**Total**
1. Technological Competency	Web Development	20	1	6	**27**
	Image Manipulation	13	8	4	**25**
	Total	**33**	**9**	**10**	**52**

Approximately half of the comments refer to issues the participants faced while working with the web development tool and 25 individual comments related to issues concerned with image manipulation. These sub-themes are discussed in detail below.

Theme 1.1: Web Development

This sub-theme referred to any comments in the data that related to issues the participants had while using website development tools to combine learning objects with learning designs. The sub-theme was supported heavily across all three types of data, especially the field notes, where 20 comments were recorded by the two observers. As well as noting this broad range of issues, the observers also indicated that they spent a lot of time aiding the participants as they used the web development tools.

This sub-theme of web development was also heavily supported in the post workshop interviews where all 5 of the interviewees indicated that they had issues using the web development tools.

The prevalence of these specific issues that were revealed during the observations, interviews and to a lesser extent the resource sheets can be seen in Table 4-9.

Table 4-9 The prevalence of issues relating to web development from the various data types

Specific Web Development Issues	Number of Supporting Comments from the Data			
	Field Notes	Resources Sheets	Interviews	**Total**
The Use of Tables within web pages	7	-	2	**9**
Website File/Folder Structure	3	-	2	**5**
Internal Hyperlinks	4	-	-	**4**
Initial set up of the Web Development Tool	3	-	1	**4**
Miscellaneous Issues	3	1	1	**5**

Table 4-9 illustrates that the participants had four types of difficulties when they attempted to use web development tools to combine learning objects with learning designs. The first major issue had to with the participants using Hypertext Markup Language (HTML) tables to help with the layout and structure of the web pages in their WebQuests. All of the participants were shown how to use tables as means of arranging text and images into multiple columns and rows, however the participants still had problems with the width feature of tables, specifically knowing when and how to use either the fixed or variable width feature of HTML tables. The second most prevalent web development issue the participant's encountered related to how the participants saved and stored their WebQuests. This resulted in problems when the participants changed computers and continued to edit their WebQuests. Specifically the issues related to the folder and file layout of the WebQuest.

The third web development issue was related to internal hyperlinks. Internal Hyperlinks are links attached to text that when activated take the user to another page within their own design and are necessary in WebQuests as they provide links to the various elements of a WebQuest. The major problem the participants encountered with hyperlinks related to the use of absolute hyperlinks, as opposed to relative links, with participants using the full Uniform Resource Locator (URL) address. The result of this was hyperlinks not working on different computers as the correct files could not be located.

This issue of hyperlinks was evident on Participant 9’s WebQuest, shown in Figure 4-3.

Please see print copy for Figure 4.3

Figure 4-3 The introduction page on Participant 9's WebQuest

The introduction page of Participant 9’s WebQuest, shown Figure 4-3, was found by the external evaluators to be visually appealing as it had an appropriate thematic element throughout, and it made good consistent use of colour. Despite this, the WebQuest’s Overall Aesthetics and functionality were hindered by the incorrect use of absolute links in the navigation bar, resulting in no internal hyperlinks working and the WebQuest scoring only 2/4 (50%) for Navigation.

The final web development issue the participants encountered as they attempted to combine learning objects with learning designs involved the initial set up of the web development tool. In this case the tool used was Macromedia Dreamweaver™, and the participants concerns were linked to the Site Definition Wizard. This wizard, which assists the user in naming the site, saving the local files in a directory on the hard drive, and uploading the site proved to be confusing for 38% (n=5) of the participants.

This sub-theme is also supported by the WebQuest evaluations, where only six (46%) of the participants managed to create a working WebQuest in the time provided and out of the six participants that did complete a working WebQuest, only one managed to get all of the navigational and mechanical aspects of the WebQuests operating correctly. This fact, and the comments, above indicate that participants had issues with using web development tools as they attempted to create a learning design.

Theme 1.2: Image Manipulation

Typically, digital images are used within WebQuests to "polish and prettify" the design (Dodge, 2004, p.1). However digital images, as explained to the participants in workshop session 2 – *The visual design of webpages,* can be much more. According to Wiley's (2000) learning object definition, a learning object is "…any digital resource that can be reused to support learning" (p. 7). Therefore a digital image that supports learning can also be classified as a learning object. This is significant as the integration of learning objects into a WebQuest is an essential part of this study.

This sub-theme referred to images that "polish and prettify" the design, as well as images that support learning (i.e., learning objects). More specifically this sub-theme referred to any comments reported in the data that related to problems the participants faced with the use and manipulation of digital images. The issue was evident across all three types of data with the two observers noting 13 individual instances during the first series of workshops where the participants had problems with manipulating images. This was exemplified in both the resource sheets and in the post-workshop interviews where 8 of the 13 participants indicated that they had problems manipulating images. The post-workshop interviews also supported this finding, where 4 out of the 5 interviewees indicated that they had issues manipulating images.

These issues were specifically concerned with the participants having problems compressing, transforming and/or reducing the scale of images so that they would look or work better in the participant's learning design.

These issues were highlighted with comments like: "I wanted to make the background of the image transparent, but I couldn't do it" (Interview of Participant 9).

An example of the resources used by Participant 12, which gives some indication into the work required in manipulating images, can be seen in Figure 4-4.

Please see print copy for Figure 4.4

Figure 4-4 Screen captures from Participants 12's WebQuest

These images shown in Participants 12’s WebQuest were scanned in high resolution from relevant photographs the participant had used previously in her teaching. This digitising process resulted in each image file being greater than four megabytes and hence deemed too large to be practical in a web page. This problem meant that the images needed to be not only reduced in quality and size, but also cropped where applicable. This procedure, while simple and efficient with the appropriate software and expertise proved to be challenging and time consuming for Participant 12 where she stated during her interview that she “… couldn’t reduce the size of the image… it was taking too long for the image to load". Observer 1 also noted during the third workshop session that Participants 10 and 12 "spent most of their time using Fireworks™ (image manipulation software) to reduce the size and quality of their scanned pics (photographs)".

Another observation made from Participant 12's WebQuest is that the basic layout of the page changes, with the navigation frame shown in the top two screen captures not appearing in the bottom two screen captures. Further investigation revealed that this issue was related to the incorrect use of URLs, adding further support to the previous sub theme of issues with web development.

The abundance of this type of data relating to image manipulation and issues with the web development indicated that the theme of technological competency was a major issue for the participants as they tried to combine learning objects with learning designs.

Theme 2: Time Limitations

The other major theme to emerge from the analysis of data had to do with the issue of time; more specifically the participants were concerned about the amount of time it was taking to create a WebQuest. This theme emerged during the workshop sessions and was noted by both observers. For example, during the third workshop session Observer 1's field notes mentioned that "John was saying that it takes forever to do this and that you seem to waste so much time… his friends agreed".

Such observations indicate that, during the course of the workshops, participants were concerned about how much time it seemed to take to create a WebQuest (i.e., a web-based learning design). Further evidence of this theme came from the resource sheets collected during the third workshop session where participants responded to the question – *What made you select these resources?* Some indicative responses included:

> "I just selected the first one I found (resource, i.e., learning object) because I was running out of time" (Interview of Participant 1)
>
> "I gave up searching and just used this one… it was taking too long" (Interview of Participant 5).

This theme was also supported during the post workshop interviews where participants responded with:

> "Not having enough time was my biggest problem" (Interview of Participant 3);

> "My biggest problem really was time" (Interview of Participant 7).

This theme was also heavily supported by the WebQuest evaluations where, as mentioned earlier, only 6 out of the 13 participants had completed a working WebQuest by the end of the workshop, despite the instruction and help provided.

The comments, observations, responses and evaluations above all indicate that the participants have problems managing the time needed to create a learning design that incorporates learning objects.

Theme 3: Resource Collection

To introduce the participants to the concepts of learning objects and their repositories, the participants were asked the following question in a group discussion at the start of the workshop: *When searching for digital resources on the Internet, where do you currently look?* A common response emerged; the major website the participants used to search for digital resources prior to the workshop was www.google.com - an Internet search program that scans web pages to find instances of the keywords, and returns a sorted list of relevant web pages. Following this discussion, the participants were then introduced to the two learning object repositories presented in the supporting website: Education Network Australia (EdNA) and Multimedia Educational Resource for Learning and Online Teaching (MERLOT). The participants were then guided through the search functions on the repositories and several 'found' learning objects were explored. Following this the participants were actively encouraged to explore the two repositories on their own, while the instructors walked around providing help and advice where needed.

Despite this introduction to learning objects and learning object repositories the analysis of data revealed that the participants were still limited in their searching for and identifying of appropriate learning objects. When questioned about this during the post-workshop interviews or on the resource sheets, two main types of responses were given.

The first type of responses were to do with the actual repository sites, where Participants 1 and 12 reported that EdNA and MERLOT were difficult to use. Participant 2 added to this when she stated she "… had trouble finding appropriate resources… because it was confusing [the EdNA search engine]" (Interview of Participant 2).

The second type of responses from the resource sheets were to do with the suitability of the learning objects the participants found. Participants 2, 4 and 8 thought that the resources they found were not appropriate to the level the WebQuest was aimed at, or that the resources did not suit the task.

This finding was also supported in external evaluations of the participants' WebQuests where the five participants who commenced the resources section received a mean score of 45% for the relevance, quantity and quality of the resources they selected. This indicates that, on average, there was only some connection between the resources the participants selected and the information the users (i.e., school students) needed to accomplish the task. Of these five participants, one did however receive full marks for the relevance and quantity of the resources they selected. However further investigation of this participant's WebQuest revealed that their main resources were not learning objects offered by either MERLOT or EdNA, but rather two basic learning objects, each in the structure of a informative web page, found by a Google™ search. The participants' resource sheets also revealed that the participants did not even consider any other resources despite several peer reviewed learning objects with similar content being available in both MERLOT and EdNA.

These types of comments indicate that specific support is needed to help the participants search for and identify appropriate learning objects that can be combined with learning designs to support the development of effective teaching and learning strategies for classroom use.

Theme 4: Pedagogical Issues

The fourth theme to arise from the first workshop was associated with the pedagogical approaches of the learning design. This became evident in the field notes where the observers both noted that, during the second and third workshop session, the participants spent more time focusing on the technical and visual characteristics of the learning design rather than the pedagogical aspect of the task. This trend in the data was also emphasised in the post workshop interviews where the following comments were made:

> "I didn't finish the WebQuest (learning design)… *Why?* …I think I spent too much time on my headings" (Interview of Participant 4)

> "I ran out of time on the task… *Why?* …I wasted time playing around with rollovers in *Dreamweaver,* but I learnt a lot!" (Interview of Participant 7)

These findings were supported in the WebQuest evaluations where the participants received a mean score of 62% for the overall aesthetics of their WebQuests, compared to a mean score of 50% of the pedagogical components of their WebQuests (i.e., the introduction, task, process and evaluation). Further investigation into this revealed that the participants scored extremely highly in the introduction, with a mean score of 95%, average marks with their tasks and processes (46% and 52% respectively) and very poorly in the evaluation section where they scored, on average, 7%. This breakdown not only adds support to the qualitative findings above, but also reinforces Theme 2 – Time Limitations as the participants appear to be running out of time in completing their WebQuests.

This further investigation also suggests that the participants may be completing each section of the WebQuest in the order that they appear in the learning design i.e., introduction, task, process, resources, evaluation, conclusion. This would help explain why most of the participants achieved diminishing scores in the WebQuest evalautions, as they were spending more time completing the introduction and running out of time before getting to the conclusion.

An example displaying both a low pedagogical task and a strong introduction can be seen in Figure 4-5

Please see print copy for Figure 4.5

Figure 4-5 Screen captures showing the Introduction, Task, Process and Evaluation page from Participant 2's WebQuest

The Noisy Insects WebQuest shown in Figure 4-5 displays four of the six critical attributes of Participants 2’s learning design. The researcher and the external evaluators both scored the introduction to be 100%, the task 30%, the process 58% and the evaluation 0%. These results suggest that Participant 2 allocated more time to the introduction section than the evaluation section. This is despite the instruction advice provided via the supporting website (Dodge, 2004), where the emphasis is on developing the task, process and evaluation attributes prior to the introduction and conclusion, as they are the most difficult and time consuming aspects of the design process.

This analysis of the WebQuest evaluations, when combined with the comments and observations, all indicate that while the participants were working on their learning designs they appeared to be spending a large proportion of their time on the introduction section and the visual and technical characteristics of the WebQuest. This could possibly be at the expense of the pedagogical aspects of the WebQuest. A potential reason for this is that a large proportion of the participants (6 out of 13) enrolled in the workshop because they were interested in gaining the technical skills necessary to develop WebQuests. Therefore the participants may have been less likely to be concerned with the pedagogy as they may think they already have that aspect under control. Despite this assumption, the lack of depth in the pedagogical sections of the learning designs still remains an issue if learning objects are to be used in a meaningful way.

Theme 5: Use of the Supporting Website

The final theme to emerge from the data related to the supporting website provided to participants to assist them as they combined learning objects with learning designs. Specifically this theme revealed that all 13 of the participants not only viewed the supporting website, but that all 13 of the participants spoke positively about the structure of the Website, and more importantly the quality of the information provided by the site. These positive comments were mainly associated with the helpful links the site provided. For example, the observers noted that the participants used and liked the linear fashion of the *Building Blocks of a WebQuest* website (Anon., 2003), this was evident with notes like;

> "… [they were] constantly referring to and using the building blocks site" (Observer 1, Workshop 1.2)

The data collected from the post-workshop interviews also supported this theme, with all 5 of the interviewees speaking about the quality, depth of and relevance of the information provided by the supporting website. These findings all suggest that the inclusion of the supporting website and the links to helpful sites were all beneficial in the aiding the participants as they combined learning objects with learning designs.

After collating and analysing the data from Stage 1 of the research it was possible to start constructing a series of initial design principles (DP's).

Stage 1: Initial Design Principles

The purpose of the design principles (DP's) was to guide the development of a support system aimed at specifically addressing the issues the participants faced as they attempted to combine learning objects with learning designs. These DP's, in the form of heuristics statements (Haney et al., 1968; Hoban et al., 1981), were derived primarily from the needs analysis, however where possible, they were also supported by current literature. The design principles are as follows:

DP 1: *A system should support teachers as they use web development tools.* This design principle was included to address the technical issues the participants had in using the HTML development tool. These technical issues were specifically associated with folder and file structure, site definition, hyperlinking and the use of tables as a means to providing structure within the pages. Therefore this DP suggests that a system which is designed to aid teachers as they combine learning objects with learning designs should provide technical support to assist teachers through these issues.

DP 2: *A system should support teachers as they incorporate digital images into their Learning Designs.* This design principle aims at addressing the technical issues the participants had when they were trying to manipulate images to use in their WebQuests. The design principle attempts to do this by suggesting that support is needed for teachers as they find, select and use more appropriate images that may not need as much, or any, manipulation. The design principle also has scope for teachers wishing to use specific, relevant or meaningful images that may require manipulation. If this is the situation then technical support should be given to teachers as they manipulate images.

DP 3: *A system should make best use of teachers' time.* This design principle was included to address the issues identified by the second theme, time limitations, which found that the participants had problems managing the time needed to create a WebQuest that combines learning objects with learning designs. The issue of time management has also proved to be a problem in other studies that have looked at the uptake of new technologies by teachers (Freebody, 2005; Smerdon et al., 2000). In order to overcome this problem a system should make best use of the teachers' time.

DP 4: *A system should support teachers as they search for appropriate learning objects*. This design principle was included to meet the issues the participants had locating and selecting appropriate learning objects to be incorporated into their learning designs. And while there is "…little research on effective web-searching instruction"(Lazonder, 2005, p.446), the research that has been conducted is inconclusive (Colaric, 2003; Colaric, Fine, & Hofmann, 2004; Gerjets & Hellenthal-Schorr, 2007; Lazonder, 2005; Liaw & Huang, 2006). To overcome this issue this design principle focuses on supporting teachers as they use more advanced searching techniques involving learning object metadata.

DP 5: *A system should direct teachers to the pedagogical aspects of the design process*. This design principle aims to alleviate the concern identified by the fourth theme – Pedagogical Issues. This principle mirrors a basic concept of learning designs by providing scaffolding to assist teachers with the pedagogical aspects of their design. Bernie Dodge, the creator of WebQuests (1995), also suggests using this approach when he directs WebQuest designers to the task, evaluation, and process sections of the WebQuest before "polishing and prettifying" the design by completing the introduction, conclusion, credits and then adding graphics at the end (Dodge, 2004).

DP 6: *The use of a supporting website can aid teachers as they combine learning objects with learning designs*. This final design principle was included because of the positive responses the participants gave towards the supporting website used in Stage 1 of the research. This design principle is in line with other recent studies that have also reported on the success of a supporting website when people are learning new technological skills (Poli, Fisher, Pollatsek, & Woolf, 2003; Zywno & Waalen, 2002). The aim of the supporting website is to organise hyperlinks to helpful websites that can aid the participants as they combine learning objects with learning designs.

Stage 1: Summary

The purpose of this stage of the study was to identify issues that teachers faced as they tried to combine learning objects with learning designs. An analysis of the data collected from field notes, resources sheets, interviews and WebQuests evaluations revealed 5 themes identifying these issues. The five themes were then used to create a series of design principles which addressed these issues. A summary of the themes and the associated design principles are shown in Table 4-10:

Table 4-10 A summary of the identified themes and constructed design principles from the first stage of the research

Themes identifying the issues that participants faced	Findings	Design principles derived from the themes
Technological Competency	Participants had issues using various aspects of the web development tool. Participants had issues manipulating digital images to use within their learning designs.	DP 1: A system should support teachers as they use web development tools. DP 2: A system should support teachers as they incorporate digital images into their learning design.
Time Limitations	Participants had issues managing the time needed to develop a learning design.	DP 3: A system should make best use of teachers' time.
Resource Collection	Participants had difficulty locating appropriate learning objects.	DP 4: A system should support teachers as they search for appropriate learning objects.
Pedagogical Issues	Participants completed the visual aspects of the learning design prior to the pedagogical aspects.	DP 5: A system should direct teachers to the pedagogical aspects of the design process.
Use of the Supporting Website	The supporting Website was successful in provided the participants with information and direction.	DP 6:The use of a supporting website can aid teachers as they combine learning designs with learning objects.

Table 4-10 shows the themes derived from the needs analysis, as well as outlining the associated design principles which specifically address the individual themes. The design principles will be used in Stage 2 of the research – the development of a prototype EPSS.

Stage 2: The Development of a Prototype EPSS

Stage 2 involved the development of a prototype EPSS designed to support teachers as they attempt to combine learning objects with learning designs. The underlying structure and content of the prototype was based on the *Guidelines for Developing a Cognitive Tool in the Form of an EPSS*, which were informed by the literature in Chapter 2, and the design principles derived from the needs analysis conducted in the previous stage of the research. By using these two sources it was possible to develop a prototype that was not only based on theory and empirical research, but also on current practices.

This section presents and describes the prototype EPSS, then discusses the development process by explaining how the prototype was constructed using the guidelines from the literature and the design principles from the needs analysis.

The Prototype EPSS

The prototype EPSS had three main components:

- A paper-based flowchart with guiding questions
- A series of learning design (i.e., WebQuest) templates
- A supporting website.

A detailed description of each component, including a rationale for their inclusion and an account of how they address the guidelines and design principles is discussed below:

Component 1: The Paper-Based Flowchart

The literature relating to scaffolding, cognitive tools and EPSSs that was reviewed for this study revealed the following five guidelines:

1. The use of a flowchart is recommended.
2. The design should be linear.
3. A system should actively engage the learner by developing and maintaining a shared goal.

4. A system should provide detailed steps with tailored assistance though cueing, prompting, questioning, modelling, telling and/or discussing.
5. A system should provide a deep approach to learning.

The first of these guidelines relates to the use of a flowchart as it was found that a flowchart could provide the necessary guidance to scaffold the design process for teachers (P. D. Johnson, 2002; LeLoup & Ponterio, 2003). Thus, component 1 of the prototype EPSS is a paper-based flowchart. This flowchart, which is shown in Figure 4-6, has two parts: a diagrammatic description of the WebQuest design process on the left hand side and a series of guiding questions on the right. Both the diagrammatic description and the guiding questions are directed at leading teachers through the process of combining learning objects with learning designs.

The second guideline states that the design of the EPSS should be linear in fashion (Cole et al., 1997; Villachica & Stone, 1999). While the fourth guideline suggests that steps in the process should be described in detail and they should provide assistance through cueing and questioning etc (Avison & Wood-Harper, 1990; Hogan & Pressley, 1997). The paper-based flowchart outlined in Figure 4-6 is clearly linear in fashion as it starts at the top by asking the user to choose a topic and to identify outcomes they wish to achieve. The flowchart then directs the user to a cyclic section. This loop is designed to reflect the interconnectedness of the pedagogical attributes of a WebQuest (i.e., the task, process and evaluation). The following aspects of the flowchart include integrating the necessary resources (i.e., learning objects) and completing the introduction and conclusion, before adding colour and graphics. The paper-based flowchart was also designed according to the defined rules and standardised symbols prescribed by the America National Standards Institute (ANSI) (Information Technology Industry Council, 2003).

Please see print copy for Figure 4.6

Figure 4-6 The first component of the Prototype EPSS – The paper-based flowchart showing the WebQuest design process

The flowchart also has detailed steps in the diagrammatic structure that are clear and concise and that are supported in part by a set of guiding questions that provide more depth. The purpose of the guiding questions is not only to provide more depth to the specific steps in the process, but also to actively engage the user and focus their thoughts and actions towards the goal – creating a WebQuest, thus addressing the third guideline.

The specific wording of the steps and guiding questions in the flowchart was adapted from three sources: The WebQuest page (Dodge, 2006); the WebQuest design process (March, 2003); and the building blocks of a WebQuest (Anon, 2003). These three sources were made available to the participants in the previous stage via the supporting website. The decision to frame the wording and design around these sources was based on the knowledge that the participants who completed a WebQuest in Stage 1 gave favourable feedback about the nature and content of these sources.

The flowchart and associated guiding questions also promote a deep approach to learning as they require the user to critically examine new facts and ideas (by answering the guiding questions), tie them into existing cognitive structures (the attributes of the WebQuest) and make numerous links between the ideas (linking the pedagogical attributes in the cyclic loop of the flowchart).

As well as addressing the guidelines revealed in the literature, the structure of the paper-based flowchart also addressed two of the design principles derived in Stage 1. It has been discovered that using flowcharts not only greatly increase the probability of completing a task, but also that flowcharts can achieve this with a minimum amount of time (Cunniff & Robert, 1987; Kammann, 1975), thus addressing design principle 3 - a system must make best use of teachers' time.

The other design principle that is addressed by the structure of the paper-based flowchart is design principle 5, which states that a system must direct teachers to the pedagogical aspects of the design process. The flowchart attempts to achieve this by scaffolding the pedagogical aspects of the design process before the 'polish and prettifying' stage. This can be seen in Figure 4-6, where the main pedagogical aspects of the WebQuest (i.e., the task, process and evaluation sections) form the central part of the design process, with only the final step of the design process involving adding graphics and colour.

Component 2: The WebQuest Templates

The second major component of the prototype EPSS was the inclusion of five specific learning design taxonomies in the form of WebQuest templates. WebQuest templates are suggested designs that can “be easily modified to cover different content while using the same basic structure” (Dodge, 2003). An advantage of a template approach to WebQuest development is that the user can download a template which contains the basic pages of a WebQuest (introduction, task, process, evaluation, etc) already hyperlinked together, with a consistent layout and a correct folder/file structure.

An example of a WebQuest template provided by the prototype can be seen in Figure 4-7 and Figure 4-8.

Please see print copy for Figure 4.7

Figure 4-7 A screen shot of the Introduction page of the WebQuest template

Please see print copy for Figure 4.8

Figure 4-8 A screen shot of the Task page of the WebQuest template

The figures above show the consistent layout of the WebQuest template provided by the prototype EPSS. The figures also show how the templates address the fourth guideline, by providing detailed steps through modelling, prompting and telling. While the layout of the templates was unique for this study, the content of the templates was adapted from the design patterns provided on *The WebQuest Portal* (Dodge, 2003).The purpose of using unique templates was two fold. Firstly, the use of unique templates allowed the WebQuest evaluators in the following stage of the research to identify the source of the participants' WebQuests. Secondly, the unique templates were designed to reduce the technical issues faced by the participants in the previous stage. More specifically the use of templates directly addressed DP 1 – a system should support teachers as they use web development tools. The use of unique templates achieve this by eliminating the need for the user to utilize the Site Definition Wizard, by providing the correct folder and file structure and by providing eight linked web pages that make use of tables to portray the WebQuest structure in a consistent format.

Another major advantage of using these types of templates was that they can provide a variety of pedagogical scaffolding on the same design framework. It is for this reason that the prototype EPSS provided four different taxonomies of WebQuest templates and one generic WebQuest template for the users to select from.

The four different templates were randomly selected from the WebQuest design patterns provided by *The WebQuest Portal* (Dodge, 2003), with the remaining generic template also coming from the portal. The types of templates provided by the prototype EPSS can be seen below in Table 4-11.

Table 4-11 A description of the WebQuest templates provided by the prototype EPSS

Please see print copy for Table 4.11

The use of these WebQuest templates also re-addresses DP 3 – A system should make best use of teachers' time. By providing a pre-made layout of a learning design, which specifically addresses the web development issues revealed in the needs analysis, time and effort can be saved or spent on other areas of the design process thus making best use of teachers' time.

Component 3: The Supporting Website

The final component of the prototype EPSS was a supporting website, the purpose of which was to provide both technological and pedagogical support to users in the form of information and resources. To achieve this, the website contained five basic pages: a Home page that welcomed the participants, a Templates page, a Repositories page, a Helpful Sites page and an Examples page. A map of the structure of the supporting website can be seen in Figure 4-9.

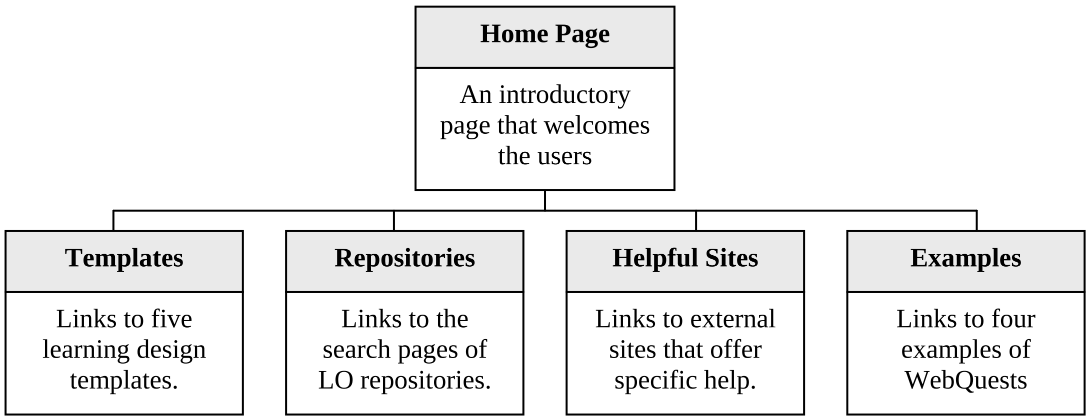

Figure 4-9 A map of the supporting website

The Templates page of the website provided both pedagogical and technical support in the form of WebQuest templates. The downloadable templates were compressed in a self-extracting format, enabling users to double click on a hyperlink and have the template not only downloaded, but also opened by the web development tool – Dreamweaver™.

The Repositories page aimed to provided pedagogical support to the user by not only providing hyperlinks to EdNA and MERLOT, the two learning object repositories used in Stage 1, but also by giving clear and concise instructions on how to search the learning object metadata in order to allocate suitable learning objects. The concise instructions and direct links were aimed to addressing the fourth design principle -a system should support teachers as they search for appropriate learning objects.

The Helpful Sites page gave technical support by providing links to specific websites. These sites and a description of them can be seen in Table 4-12.

Table 4-12 A description of the external links on the supporting website's Helpful Sites page

Helpful Websites linked to the Supporting Website	Description
Best Animations	A large searchable digital library containing a collection of animated images specifically designed for the Internet. http://bestanimations.com/
Clipart.com	The largest collection of royalty-free clipart images, photos, Web graphics, illustrations, fonts, and sounds on the World Wide Web. http://clipart.com
Guide to Adobe Photoshop	A beginner’s guide to Adobe Photoshop, which contains tutorials and information about basic Photoshop concepts, allowing the users to gain skills in resizing images http://www.pegaweb.com/tutorials/beginners-guide-adobe-photoshop/
A users guide to Dreamweaver	This website contains easy to read tutorials about specific tasks in Dreamweaver, allowing teachers to search for and get help when they require it. http://livedocs.adobe.com/dreamweaver/8/

The first three of these links were included to address the second design principle - a system should support teachers as they incorporate digital images into their learning designs. To achieve this the web page contained hyperlinks to a number of external websites. The first two of these sites were selected because they provided access to free images and graphics that were specifically designed for web pages, thus eliminating the need for the participants to use and potentially manipulate their own images. The third website was also included to address DP 2 as it provided users with information about, and tutorials on, the image manipulation software used in the workshops (Adobe Photoshop ™).

The fourth and final link in the Helpful Sites section of the supporting website addressed DP 1 – A system should support teachers as they use web development tools. It aimed to achieve this by providing tutorials and useful information about Dreamweaver™, the specific web development tool used in the workshops.

The last page of the supporting website was the Examples page. This paged provided pedagogical support by containing links to the four exemplary WebQuests used as examples in the initial supporting website. The purpose of this page was to provide a series of outstanding WebQuests that teachers could observe, explore and learn from.

Screen shots of the supporting website can be seen in Figure 4-10 and Figure 4-11.

Please see print copy for Figure 4.10

Figure 4-10 A screen shot of the home page of the supporting website

Please see print copy for Figure 4.11

Figure 4-11 A screen shot of the Templates page of the supporting website

These screen shots show the underlying design, structure and colour scheme of the supporting website as well as the basic layout. This was consistent through out all five pages of the site, allowing users to recognise whether they were on the 'WebQuest Home Page" or an external website.

Stage 2: Summary

The purpose of this stage of the research was to develop a prototype EPSS aimed at addressing the issues of teachers as they combine learning objects with learning designs.

The foundations of the prototype were based on guidelines revealed from an in-depth review of the literature, while the specific content of the prototype came from design principles derived in Stage 1. An overview of how these guidelines and design principles were addressed by the prototype can be seen in Table 4-13.

Table 4-13 An outline of how the prototype EPSS meets the guidelines identified from the literature and how it addresses the issues of the participants

Guidelines for Developing a Cognitive Tool in the Form of an EPSS	Designs Principles Derived from Stage 1	Features of the Prototype that addresses the Guidelines and Design Principles
1. The use a flowchart is recommended.	-	The flowchart follows defined rules and standardised symbols prescribed by the ANSI.
2. The design should be linear.	-	The prototype is linear.
3. A system should actively engage the learner by developing and maintaining a shared goal.	-	The goal of creating a WebQuest is reinforced through engaging question and a novel design.
4. A system should provide detailed steps with tailored assistance though cueing, prompting, questioning, modelling, telling and/or discussing.		The steps are described in detail Guiding questions are used to provide more detail and direction.
5. A system should provide a deep approach to learning.		Users are required to critically examine the guiding questions, and use the answers to make links between the various pedagogical attributes of their learning design.
-	DP 1: A system should support teachers as they use web development tools.	WebQuest Templates Online tutorials.
-	DP 2: A system should support teachers as they incorporate digital images into their learning designs.	Links to digital libraries containing images specifically for web pages. Online tutorials.
-	DP 3: A system should make best use of teachers' time.	The prototype is time efficient through its design, the use of templates, and by the information provided by supporting website.
-	DP 4: A system should support teachers as they search for appropriate learning objects.	A supporting website that contains links to and information on how to use learning object repositories.
-	DP 5: A system should direct teachers to the pedagogical aspects of the design process.	The structure of the prototype directs users to the pedagogical aspects of the WebQuest.
-	DP 6: The use of a supporting website can aid teachers as combine learning objects with learning designs.	A supporting website was constructed that provides links to templates, tutorials, repositories, and examples of WebQuests.

Having investigated and identified the issues that the participants faced, and then having designed and developed a prototype EPSS to address these issues, it was possible to move onto the next stage of the research.

Stage 3: Evaluating the Prototype EPSS, Continuing the Needs Analysis and Refining the Design Principles

Stage 3 of the research involved three distinct phases. The first phase involved evaluating and testing the prototype EPSS. The concurrent second phase was directed at continuing the needs analysis started in Stage 1. The third phase looked at refining the design principles to further guide the future development of the EPSS. These phases were specifically designed to address all three research questions.

1. *What are the issues that teachers face as they combine learning objects with learning designs?*
2. *What design principles guide the development of systems and supports which assist teachers as they combine learning objects with learning designs?*
3. *How do systems and supports address the issues teachers face as they combine learning objects with learning designs?*

To respond to these questions, an overview of the results from the WebQuest evaluations and the analysis of the field notes, resources sheets, and interviews will be presented. Following this the themes derived from the analysis will be discussed in detail. Then based on these discussions the design principles created in Stage 1 will be revisited and refined where necessary.

Stage 3: Data Analysis

To ensure reliability, the data collected from the 12 participants in this stage was analysed in a similar fashion to Stage 1. Likewise the analysis of the data and subsequent discussion will also be structured in the same way, with an overview being presented before a detailed breakdown.

As in Stage 1 the first type of artefact to be analysed was the participants’ completed WebQuests. These WebQuests were again collected from the participants at the conclusion of the series of workshops. This time 8 out of the 12 participants (66.7%) had created a WebQuest to a standard that could be evaluated. A researcher evaluation was conducted on these eight WebQuests, with a descriptive overview from this evaluation being shown in Table 4-14. The complete results of the researcher evaluation are shown in Appendix N.

The descriptive overview revealed that five out of the eight WebQuests created were science based, ranging from WebQuests where users need to create and name a new dinosaur, to WebQuests where users need to find and critically examine the life cycles of living organisms. The remaining three WebQuest were based in the English, Humanities and Art areas and involved users investigating the difference between capital and small letters, the effectiveness of global aid organisations and researching pieces of art related to human faces.

An interesting point to note about the WebQuests completed in this stage of the research is that seven out of the eight participants (87%) had commenced all of the attributes of the WebQuest framework. This is a slight improvement on the previous WebQuests where five out of the six participants (83%) had commenced all the attributes. This and other issues related to Table 4-14 are discussed later in this section.

Table 4-14 A description of the WebQuests collected after the second series of workshops

Participant	Description
15	Title: DinoQuest Focus: Not Given Description: In this WebQuest students are given the ‘dangerous’ task of searching the WWW to find facts on dinosaurs, then they can create and name their own dinosaur. Level of Completion: 5/5 attributes commenced
16	Title: Frankie’s One Stop Organ Shop Focus: Ages 14 - 15 Description: This WebQuest requires students to research a body organ and then design a poster for ‘Dr. Frankenstein’ which sells the body organ. Level of Completion: 5/5 attributes commenced
17	Title: Life Cycles Focus: Ages 14 - 15 Description: During this WebQuest students are required to imagine that they are sent on a mission to earth to investigate living objects and compare their life cycles. Level of Completion: 5/5 attributes commenced
19	Title: Under the Sea Focus: Not Given Description: Students are required to don a detective hat in this WebQuest and investigate various sea animals and find out about their habitats, what they eat and look like. Level of Completion: 5/5 attributes commenced
21	Title: Greenhouse Effect Focus: Ages 14 - 15 Description: The WebQuest involves a group of students researching the Greenhouse effect and developing a PowerPoint presentation on how to reduce the effect of it. Level of Completion: 4/5 attributes commenced
22	Title: Nemo Alphabet Focus: Ages 5 - 6 Description: This WebQuest requires students in Kindergarten or year 1 to look at the difference between capital letters and small letters Level of Completion: 5/5 attributes commenced
24	Title: It’s your Choice Focus: Ages 14 - 15 Description: In this WebQuest students have to research the effectiveness of various global aid organisations and award one of them with aid organisation of the year. Level of Completion: 5/5 attributes commenced
25	Title: Faces – Elements of Art Focus: Ages 14 - 15 Description: A group of students imagine that they are museum curators in this WebQuest. The have to research various pieces of art related to human faces. Level of Completion: 5/5 attributes commenced

An example of one of the WebQuests (Participant 16's) from this stage of the research can be seen in Table 4-12.

Please see print copy for Figure 4.12

Figure 4-12 Four screen shots of Participants 16's WebQuest

The table shows the home, introduction, task and process screens of a WebQuest where users are required to design an eye catching poster for a spare body part. An interesting observation to make from this novel WebQuest is that the underlying structure of this WebQuest is based on the generic template provided by the supported website (see Figure 4-7 and Figure 4-8). This can be seen in the structure of the task bar and size of the headings, although an official confirmation of this was only obtained after an analysis of the HyperText Markup Language (HTML) behind the pages.

To formally evaluate this, and the other WebQuests from Stage 3, a review of the eight WebQuests was initially conducted by the researcher. The full results of this evaluation can be seen in Appendix N. An example of the results from Participant 16's WebQuest evaluation is show in Table 4-15. This table shows that the novel WebQuest shown in Figure 4-12 was awarded nine out ten for overall aesthetics of the design, only losing one mark because the reviewer thought that the overly bright colour could distract possible users from the task.

Another observation made from the researcher evaluation of Participants 16's WebQuest was that the reviewer found the Introduction to be engaging and motivating as it presented the topic in an interesting and novel way:

> *"Congratulations! You have been selected to design a poster for Dr. Frankenstein's One Stop Organ Shop.*
>
> *Please remember that Dr. Frankenstein does not like to be disappointed"*
>
> (Introduction from Participant 16's WebQuest).

The researcher evaluation also indicated that Participant 16's Task was engaging and 'doable' – a phrase taken from the WebQuest evaluation rubric (Bellofatto et al., 2001) indicating that the task is feasible.

Table 4-15 The researcher evaluation of Participant 16's WebQuest

Please see print copy for Table 4.15

Following evaluation by the researcher, to ensure reliability, these eight WebQuests were also reviewed by the same two external evaluators used in Stage 1. Just like Stage 1 the evaluators' individual results were compared to see if there was a high level of agreement between their assessment. This comparison returned an inter-observer agreement of 84.66% which indicated that there was a high level of agreement between the scores of the evaluators. The mean scores from the evaluators were calculated with the results shown in Table 4-16.

An observation to make from the results shown in Table 4-16 is that seven out of the eight WebQuests achieved above average results. A breakdown of this encouraging outcome revealed that all of the participants scored positively in the overall aesthetics of their WebQuests and that all eight achieved 50% or more with the motivational and cognitive effectiveness of their introductions. Another promising observation is the seven out of the eight participants achieved above average marks for the overall quality of the process involved in their WebQuests. These results however were off-set by the low scores attained in the evaluation section where only four out of the eight of the participants achieved 50% or more and where the most prevalent score was zero.

Table 4-16 The mean scores from three evaluations of the participants' WebQuests in Stage 3 of the research

		Participants							
		15	16	17	19	21	22	24	25
Overall Aesthetics	Visual Appeal /4	4	3	4	4	4	2	2	4
	Navigation /4	4	4	4	2	2	2	2	4
	Mechanical Aspects /2	1	2	1	2	1	1	1	2
	Sub-Total /10	**9**	**9**	**9**	**8**	**7**	**5**	**5**	**10**
Introduction (Learning Supports)	Motivational Effectiveness /2	1	2	2	2	2	1	1	2
	Cognitive Effectiveness /2	1	2	1	2	2	1	0	0
	Sub-Total /4	**2**	**4**	**3**	**4**	**4**	**2**	**1**	**2**
Task (Learning Tasks)	Connection of Tasks to Standards /4	2	2	0	2	0	0	0	0
	Cognitive Level of Tasks /6	2	6	3	6	6	0	6	3
	Sub-Total /10	**4**	**8**	**3**	**8**	**6**	**0**	**6**	**3**
Process (Learning Supports)	Clarity of Process /4	4	4	2	4	4	2	4	4
	Scaffolding of Process /6	2	3	6	4	4	0	3	4
	Richness of Process /2	1	1	2	2	2	0	1	1
	Sub-Total /12	**7**	**8**	**10**	**10**	**10**	**2**	**8**	**9**
Resources (Learning Objects)	Relevance / Quantity of Resources/4	2	2	4	2	2	0	2	2
	Quality of Resources / 4	2	4	4	2	2	0	2	0
	Sub-Total /8	**4**	**6**	**8**	**4**	**4**	**0**	**4**	**2**
Evaluation (Learning Supports)	Clarity of Evaluation /6	**0**	**0**	**3**	**0**	**6**	**n/c**	**3**	**6**
TOTAL (%)	**includes only attributes commenced**	**52**	**70**	**72**	**68**	**73**	**21**	**53**	**63**

(N.B. A higher number represents a better result)

n/c = Indicates that the participants did not commence that section

These positive preliminary findings are supported further when the quantitative data from Stages 1 and 3 of the research are compared. An overview of this comparison can be seen below in Table 4-17.

Table 4-17 Comparisons between the means of the WebQuest evaluations from workshop series 1 and workshop series 2

	Workshop Series 1 n=6	**Workshop Series 2 n=8**
Overall Aesthetics /10	5.83	7.75
Introduction /4 (Learning Supports)	3.80	2.75
Task /10 (Learning Tasks)	4.17	4.75
Process /12 (Learning Supports)	6.40	8.00
Resources /8 (Learning Resources)	3.60	4.00
Evaluation /6 (Learning Supports)	1.40	2.57
TOTAL (%) [a]	**46.33**	**57.75**

[a] The total only includes attributes commenced

The major comparison to make initially from the data displayed in Table 4-17 is the 11.42% (from 46.33% to 57.75%) increase in the mean total scores of the WebQuest evaluations from workshop series 1 to workshop series 2. While the statistical significance of this increase was not realised, largely due to the small sample size and high standard deviations, descriptive trends do change and this suggest the value of the prototype EPSS. Another observation to make is that the average scores in five out of the six sections of the evaluation rubric increased in the second series of workshops, with only the introduction section declining.

These initial findings will be discussed in conjunction with issues arising from the analysis of the qualitative data collect in this stage. This data was again coded into the broad category of the issues participants faced, however this time the data was also coded into the themes that surfaced from the previous needs analysis. This allowed for comparisons between the two needs analyses to be made.

As the data was investigated and trends began to emerge, the same five themes resurfaced: *Technological Competency, Time Limitations, Resource Collection,* *Pedagogical Issues*, and *Use of the Supporting Website*, however two new themes: *Flowchart Usage* and *Template Usage* were also revealed. The number of individual comments relating to each of the themes can be seen below in Table 4-18.

Table 4-18 The prevalence of themes derived from the data collected during Stage 3

Major Themes	Sub-Themes	Number of Supporting Comments from the Data			
		Field Notes	Resources Sheets	Interviews	**Total**
1. Technological Competency	Web Development	7	-	4	**11**
	Image manipulation	4	-	-	**4**
2. Time Limitations	-	7	6	5	**18**
3. Resource Collection	-	8	12	5	**25**
4. Pedagogical Issues		8	4	7	**19**
5. Use of Supporting Website	Strengths	7	10	5	**22**
	Weaknesses	-	-	-	**0**
6. Flowchart Usage	Strengths	10	2	5	**17**
	Weaknesses	-	-	-	**0**
7. Template Usage	Strengths	6	-	5	**11**
	Weaknesses	-	-	-	**0**

The table shows that of the seven themes derived from the data, resource collection was the most prevalent issued faced, closely followed by pedagogical issues and time limitations. The table also reveals that only positive comments were made about the three components of the prototype EPSS: the flowchart, the templates and the supporting website.

These seven themes and the success of the prototype will be discussed below in relation to the trends identified in Table 4-16 and Table 4-17. Five of these themes (*Technological Competency, Time Limitations, Resource Collection, Pedagogical Issues, and the use of the Supporting Website*) identified the issues the participants faced in the first series of workshops. As the major aim of the prototype EPSS was to address these themes, the success of the prototype can also be measured on how well it alleviated the issues associated with these themes. In addition, this section also reports on the new themes to emerge from the data collected in this stage *Paper-Based Flowchart Usage* and *Template Usage.*

Theme 1: Technological Competency

The theme of technological competency, as in the first needs analysis, refers to the practical computer related difficulties experienced by the participants during this stage. This theme also contained two sub-themes, web development and image manipulation. The issues relating to these sub-themes were addressed by the prototype EPSS in two main ways, firstly through the use of WebQuest templates and secondly by the supporting website providing links to online tutorials and digital libraries containing images specifically for web pages.

The analysis of qualitative data collected in this stage uncovered no new sub-themes relating to technical competency. However the first sub-theme, web development, which related to any issues the participants' had while using website development tools, was still found to be an issue. This is despite a drop of 60% (from 27 to 11) in the number of supporting comments in the data. A more in-depth analysis of the 11 supporting comments found that the issues related to web development could not be grouped any further, with the participants having an assortment of specific technical issues. These issues included problems with nested tables, wanting external hyperlinks opening in separate windows, modifying the background of the learning design and changing the page's title.

The analysis also revealed that the second sub-theme of image manipulation was not heavily supported with the observers only recording four instances during the course of the workshops where the participants had issues with images. These four issues were all related to the participants generating graphics created by the free online tool - Flaming Text (Bonnell & Gregory, 2005). The participants were all made aware of Flaming Text during informal discussions prior to the second workshop by a fellow participant. While this tool enabled the participants to insert novel headings into their WebQuests, as shown in Figure 4-13, it did prove to be a time consuming process that 33% (n=4) of the participants had issues with.

Please see print copy for Figure 4.13

Figure 4-13 Examples of two images generated by Participants 22 and 24 using the free online tool, Flaming Text (Bonnell & Gregory, 2005)

On top of these observations the quantitative WebQuest evaluations revealed a positive increase of 7% in the navigation and mechanical aspects of the learning designs created in the second workshop series.

An example of a participant's WebQuest which was assessed by all three evaluators as have no mechanical problems (100%), indicating that it contain no broken hyperlinks and missing images can be seen in Figure 4-14. This WebQuest was also found to have a very high level of visual appeal (100%) demonstrating that the evaluators thought that the WebQuest contained appropriate and thematic graphic elements and that type size and colour were well used and consistent.

These mechanical and visual components are directly related to the technological concerns the participants faced as they involve web development issues and image manipulation. Further investigation of these components in Participant 19's WebQuest revealed that web development issues were averted by directly using the generic template provided via the supporting website. It was also found that the thematic graphics inserted into the WebQuest (see Figure 4-14) were all downloaded from the digital image libraries provided by the supporting website. Hence, these graphics required only minor manipulation in the form of scaling – a simple highlight and drag procedure within the web development tool.

Please see print copy for Figure 4.14

Figure 4-14 Screen shots of Participants 19's WebQuest

These findings suggest that the visual appeal and mechanical aspects of a learning design can be improved through the use of templates and a supporting website which contains links to online tutorials and digital image libraries.

Theme 2: Time Limitations

The theme of *Time Limitations* referred to the concerns the participants had with the amount of time required to create a learning design in the form of a WebQuest. These concerns were addressed by the design of the paper-based flowchart and the time saving components of the supporting website. Even though the issue of time limitations reappeared as a theme in the data in this stage of the research, the actual design of the prototype EPSS can still be called a success in terms of managing the participants' time. Two factors lead to this conclusion. Firstly, only 46% of the participants in Stage 1 of the research created a WebQuest to a working standard, compared to 66% with the aid of the prototype EPSS – a 20% increase. Secondly, as mentioned earlier, not only were more WebQuests created in the same amount of time but on average the WebQuests created with the aid of the prototype EPSS scored 9.75% higher in the WebQuest evaluations, indicating that they were of higher quality.

Despite these quantifiable improvements the issue of time limitations was still a concern for the participants. This theme showed through consistently in the field notes and resource sheets, with instances being recorded 13 times about issues related to the time taken to create a WebQuest. Even more support for this issue came from the post workshop interviews where 100% (n=5) of the interviewees commented on the large amount of time needed to create a WebQuest.

These results, while positive in one sense, still indicate that the participants have problems managing the time needed to create a WebQuest which makes use of learning objects. This issue is closely related to a concern identified by Eltis (2003) when he conducted a state wide study investigating demands placed on NSW teachers. After collecting and collating a wide variety of data from teachers, principals, parents and students, as well as from educational authorities and professional associations, Eltis made several key recommendations to the NSW State Government. One of these recommendations was "…to free up teacher time to allow more time to be spent in planning for teaching and devising of innovative tasks for students in all areas" (p. 97). The second theme in this stage of the research also supports this recommendation.

Theme 3: Resource Collection

This recurring theme was the most prevalent theme in this stage of the research, with over 25 individual comments relating to issues the participants faced as they searched for and identified resources (i.e., learning objects). This is despite the researchers giving participants directions in, plus tutoring in how to use, the learning object repository search engines associated with EdNA and MERLOT.

The major issue the participants reported when using these repository search engines was pointed out by Participant 17 when she said that the interface of EdNA and MERLOT seemed “…confusing, compared to Google™”, and that “Google™ was easier because it found the things you wanted”. When questioned further about this Participant 17 replied that she knew of a learning object and wanted to use it and that Google™ found it quickly. Further investigation of this allegiance to Google™ revealed that 100% of the participants indicated on their resource sheets that they had used Google™ to use locate some of the resources they had planned on using in their WebQuests.

The issues associated with using Google™ became evident during the external evaluation of the participants’ WebQuests. This evaluation revealed that only 1 participant received high results for the relevance, quality and quantity of the resources used in their WebQuests, with the average being just 50%, only a slight improvement (5%) over the WebQuests from Stage 1. Further investigations of the completed WebQuests revealed, once again, that no learning objects from either EdNA or MERLOT were used in the participants WebQuests. This is despite both the observers noting that the participants had a solid understanding of how to use the repository search engines.

The resources that seven of the participants used in their WebQuests were basic informative websites. Five of these participants reported via their resource sheets that the resources they used in their WebQuests were found using Google™, with another two participants reporting that they used websites that they were already familiar with. It was interesting to note that Participant 25 revealed on her resource sheet that she “just stumbled across it (an image used as a learning object) when …*she*... was looking for something else”.

Screen shots of two informative websites that participants used as learning objects can be seen on the left hand side on of Figure 4-15. These simple linear websites provided the factual information needed to solve the participants Tasks. The screen shots on the right hand side on Figure 4-15 show corresponding, specifically designed, learning objects. These specifically designed learning objects were located quickly and easily using EdNA's basic search engine (Education Network Australia, 2005) which was supplied via the supported website. This may indicate that the participants did not know how to search for or identify specifically designed learning objects.

Please see print copy for Figure 4.15

Figure 4-15 Screen shots of two learning objects used in Stage 3 of the research, and similar specifically designed learning objects

The specifically designed learning objects, shown on the right hand side of Figure 4-15, challenge students to question, investigate, analyse, synthesise, solve problems, make decisions and reflect on their learning (BBC Worldwide, 2005a, 2005b) rather than just recall information. If these specifically designed learning objects are to be successfully located and incorporated into learning designs even greater support for teachers is needed.

Theme 4: Pedagogical Issues

The other issue that was reinforced by the second needs analysis was that the participants were still spending a large proportion of their time making their learning designs visually appealing. This appeared detrimental to the pedagogical focus of the design, namely the cognitive level of the task, the richness of the learning process and the clarity of the evaluation criteria. Evidence to support this came from the WebQuest evaluations, where the participants achieved on average 84% for the visual appeal of their learning design, but only 66%, 62% and 28% respectively for the cognitive level of their tasks, the richness of their learning processes and the clarity of their evaluations. An example of a visual appealing WebQuest with a poor process can be seen in Figure 4-16.

Please see print copy for Figure 4.16

Figure 4-16 Participant 15's WebQuest showing a high level of aesthetics, but low pedagogical structure

Figure 4-16 shows screen shots of four sections of Participant 15’s WebQuest. This WebQuest scored 9 out of 10 for overall aesthetics, indicating that the evaluators thought that the WebQuest was visually appealing and that the navigation was seamless, although a few broken external hyperlinks were noted. The pedagogical aspects of participant’s WebQuest failed to perform as well, with the cognitive level of the Task evaluated to be two out of six, the richness of the Process achieved one out of two, and the Evaluation received zero as it was commenced but failed to contain any useful information. Closer examination revealed that the Task involved simply recalling information from several sources, and that the process required to achieve this did not invoke a deeper approach to learning.

Exploration of the field notes revealed that Participant 15, like many of the participants, was observed spending large amounts of time on the visual components of her WebQuest. In Participant 15's case, she was observed spending 50 minutes learning how to create web buttons, these can be seen on the left hand side on of her various screen shots shown in Figure 4-16. When asked about this in the post workshop interview, Participant 15 said she enjoyed "…working on the fun stuff", referring to the web buttons, despite this being at the expense of creating a meaningful and engaging Task.

Further evidence to support the theme that participants were spending greater amounts of time on the visual aspects of their learning design, as opposed to the pedagogical side, came from the participants' resource sheets. Here it was noticed that 33% (n=4) of the participants selected their resources because they could be easily adapted to suit the visual aspects of their learning design, not because they complimented the pedagogical aspect.

This analysis clearly points out that the participants are still spending large amounts of their time on the visual characteristics of their learning design, as opposed to the pedagogical aspects and that greater structure is required to direct the participants towards creating the Task, Process and Evaluation sections.

Theme 5: Use of the Supporting Website

The fifth theme associated with this stage of the research looked at the suitability of the supporting website as a means to address some of the issues participants face as they tried to combine learning objects with learning designs. The supporting website attempted to do this by providing information, learning design templates and hyperlinks to resources. An analysis of the data from the field notes, resources sheets and interviews revealed only positive comments about the suitability of the supporting website. An example of this was during the first workshop of the series where both observers noted that all the participants were exploring the supporting website and external sites it linked to. Observer 2 also noted during the second workshop that "…three people are using the help site (Dreamweaver tutorial) to fix up their web page", indicating that the participants had web development issues, but were actively seeking solutions themselves. This deduction was supported during the post workshop interviews where Participant 19 stated that when he had technical problems creating hyperlinks to documents he looked for and found help through the supporting website.

The interviews also revealed that the participants found the supporting website "…easy to use" (Participants 17 and 19) and the links provided by the helpful sites page "…were very useful" (Participant 23).

Further evidence indicating the merits of the supporting website came from the resource sheets where 9 participants reported that they used images in their learning designs from the digital libraries which they located via the supporting website.

Overall these findings do indicate that a website can be utilised as a support mechanism to aid teachers as they try to combine learning objects with learning designs. This theme also adds support to the third theme of resource collection, with greater assistance needed for teachers as they search for and identify appropriate learning objects.

Theme 6: Flowchart Usage

This theme refers to any comments made by the participants or the observers during the second series of workshops that related to the use of the paper–based flowchart. Initial observations of the data revealed that all 17 of the recorded comments about the paper-based flowchart were positive. An example of this came from the field notes where it was recorded by both observers that all the participants were looking at the flowchart and speaking favourably of it. The post workshop interviews also supported this view with all 5 (100%) interviewees speaking positively about flowchart. With Participant 18 stating that he "… worked through it." from start to finish, and that he "… used it all the time". Observer 1 also noted during the final workshop of the series that Participant 21 had:

> "… designed his WebQuest as the flowchart suggested. He has finished the task/process and is making the pages suit the task, e.g. adding pictures, colour and animation" (Observer 1, Workshop 2.4).

The evaluations of the participants WebQuest revealed that Participant 21 achieved the highest combined scores for the pedagogical aspects of the WebQuest (22/28) as well as achieving the highest score so far in the study (74/100). A similar situation occurred with Participant 17 who achieved the second highest score in the WebQuest Evaluation (72/100). She stated during the post workshop interview that she used the flowchart and found it “helpful”.

These findings suggest that not only did the participants like the flowchart design, but more importantly that the flowchart did provide the necessary sequence of steps and guidance required to create pedagogical sound learning designs. This means that these steps and the guiding questions associated with them can be utilised in the future iterations of the development research process.

Theme 7: Template Usage

The final theme to emerge from the data, as the participants tried to combine learning objects with learning designs with the aid of the prototype EPSS, related to the participants use of learning design templates. The five templates, made available through the supporting website, were aimed at making the best use of the participants’ time by providing pre-made layouts of learning designs. The templates not only provided indirect technical support by containing the basic HTML code needed to construct WebQuests, but they also provided a variety of pedagogical approaches for the participants to chose from.

Analysis of the data revealed only positive comments about the use of the templates. An example of these positive comments was during the first workshop session where both observers noted the participants were not only exploring the templates, but also commenting about how easy the templates were to use. Observer 1’s field notes also indicated that during the third workshop session the participants who continued to use the templates, without modifying them, were closer to finishing their learning designs. This point was also highlighted by the WebQuest evaluations, where further examination revealed that the participants who did not modify the structure of the template achieved near perfect results for the navigational and mechanical aspects of their WebQuest, whilst those participants who attempted to modify the design either achieved lesser marks or failed to submit their WebQuest for evaluation because it was not finished.

The transcripts from the five recorded interviews also gave a greater insight into the suitability of the WebQuest templates as a way of addressing some of the issues the participants faced as they tried to combine learning objects with learning designs. All five of the interviewees commented on how easy the templates were to use.

Another interesting observation about the data relating to the use of the templates was the absence of any comments describing issues associated with the Site Definition Wizard or the folder and file structure of the learning designs. This also emphasises the success of the template approach in alleviating these issues.

Stage 3: Refining the Design Principles

This phase of the Stage 3 of the study aimed at addressing the second research question:

> *What design principles guide the development of systems and supports which assist teachers as they combine learning objects with learning designs?*

To answer this question it was necessary to revisit the design principles created in Stage 1 and then refine these principles based on the collated and analysed data from Stage 3 of the research. The refined design principles at the end of this stage of the research are:

DP 1: *A system should support teachers as they use web development tools.* This original design principle, was specifically aimed at solving the problems associated with folder and file structure, site definition, hyperlinks, and the use of tables used to define the layout of the WebQuest. As the analysis of the data from this stage of the research revealed that the participants did not have these problems, this DP can be judge a success. Therefore no refining of DP1 was required.

DP 2: *A system should support teachers as they incorporate digital images into their learning designs.* This design principle originally focused on supporting teachers as they find, select and use images in their learning designs. Although the analysis of the data did reveal a minor issue associated with the use of images from the external website Flaming Text (Bonnell & Gregory, 2005), it did alleviate most of the issues and therefore no refining is necessary.

DP 3: *A system should make best use of teachers' time.* This original design principle focused on making good use of teachers' time. As the data analysis from this stage of the research uncovered the fact that time limitations were still a major issue faced by the participants as they attempted to combine learning objects with learning designs, this design principle needs to be strengthened. Therefore DP 3 has evolved into the stronger statement: *A system must make best use of teachers' time.*

DP 4: *A system should support teachers as they search for appropriate learning objects*. This DP focused on supporting teachers as they used more advanced searching techniques involving learning object metadata to locate appropriate learning objects. As the analysis of the data revealed that the participants WebQuests contained no learning objects from either of the two learning object repositories this designed principle also needs to be strengthened. Therefore DP 4 has been refined and now states: *A system must support teachers as they search for and locate appropriate learning objects*.

DP 5: *A system should direct teachers to the pedagogical aspects of the design process*. This design principle focused on directing the teachers towards developing the pedagogical aspects of their learning designs before they begin working on the visual aspects. The analysis of the data clearly pointed out that the participants who work through the pedagogical aspects of the design process, before "polishing and prettifying" their design, achieved greater results in the WebQuest evaluations, indicating that this design principle can be called a success. However with only 66% of the participants completing their learning designs and with the average WebQuest evaluations scores being 57.75% more direction is clearly needed. Therefore DP 5 has also been strengthened and now states: *A system must direct teachers to the pedagogical aspects of the design process before the visual aspects of the design.*

DP 6: *The use of a supporting website can aid teachers as they combine learning objects with learning designs*. This DP aimed to support teachers as they combined learning objects with learning designs by providing hyperlinks to helpful websites. The overriding success of the supporting website outlined by the data analysis in Stage 3 of the research indicated the success of this DP, and therefore no changed is required to the statement.

These six design principles have been implemented, evaluated and refined from the initial design principles created in Stage 1. This procedure also gave the opportunity to implement and evaluate the *Guidelines for Developing a Cognitive Tool in the Form of an EPSS,* derived during the literature review in Chapter 2. This process enabled the development of five additional design principles. These supplementary design principles are:

DP 7: *A system should be linear in design.* This new DP is not only grounded in theory identified during the literature review on the design concepts for EPSSs (Cole et al., 1997; Villachica & Stone, 1999), but is also based on the analysis of the data collected in the research thus far. This DP indicates that the system should have a definite starting point, with a progression of steps that lead to a distinct end point.

DP 8: *A system should actively engage the learner by developing and maintaining a shared goal.* This DP is based on a corresponding guideline that was implemented earlier in this stage of the research. The initial guideline was derived from an extensive review of the literature relating to scaffolding learning experiences (Hogan & Pressley, 1997) and on literature surrounding computer-based cognitive tools (Jonassen, 1994; Kennedy & McNaught, 2001). The DP suggests that a system designed to aid teachers as they combined learning objects with learning designs should engage the teachers by developing and maintaining a shared goal – the development of a learning design which incorporates learning objects in this case.

DP 9: *A system should provide detailed steps with tailored assistance through cueing, prompting, questioning, modelling, telling and/or discussing.* This is a new DP that is also grounded in literature (Avison & Wood-Harper, 1990; Hogan & Pressley, 1997) and supported by the data, where the analysis suggested that participants who followed the flowchart model, where the steps were described in detail, created stronger learning designs. Therefore the ninth DP indicates that all instructions given to teachers as they try to combine learning objects with learning designs should be described in detail.

DP 10: *A system should provide a deep approach to learning.* The DP has its foundations in the literature relating to scaffolding (Hogan & Pressley, 1997) and on literature surrounding computer-based cognitive tools (Jonassen, 1994; Kennedy & McNaught, 2001). The DP suggests that a system designed to support teachers as they combine learning objects with learning designs should provide opportunities for the teachers to critically examine appropriate information and resources and make links between these and the various pedagogical attributes of a learning design. By working through this process it is believed (Biggs, 1999; Entwistle 1988; Ramsden, 1992) that learners can develop a higher level of competence.

DP 11: *A system should contain design templates.* The final design principle suggests that a system which supports teachers as they try to combine learning objects with learning designs should contain a variety of design stencils that can be easily modified by teachers to cover different content. This DP was heavily supported from the analysis of the data thus far in the study. The analysis clearly revealed that the given templates assisted the participants as they combined learning objects with learning designs by alleviating a number of technical issues.

Stage 3: Summary

The purpose of this stage of the research was to evaluate the prototype EPSS and continue the needs analysis, with the aim of refining the design principles. The analysis of the data collected from field notes, resources sheets, interviews and WebQuests evaluations supported the five previous themes identified in Stage 1 and revealed two new themes. The seven themes were then used to refine the initial design principles created in Stage 1 of the research. A summary of the seven themes, the findings associated with them and the relevant refined design principles is shown in Table 4-19.

Table 4-19 A summary of the identified themes and the refined design principles after Stage 3 of the research

Themes identifying the issues that participants faced	Findings	Design principles derived from the themes
Technological Competency	The use of WebQuest templates and online tutorials successfully reduced this issue Providing hyperlinks to online digital libraries and online tutorials successfully reduced this issue.	DP 1: A system should support teachers as they use web development tools DP 2:A system should support teachers as they incorporate digital images into their learning designs
Time Limitations	Participants still had issues managing the time needed to develop a WebQuest, despite the measures put in place.	DP 3: A system must make best use of teachers' time
Resource Collection	Participants continued to have difficulty locating appropriate learning objects, and showed allegiance to Google™	DP 4: A system must support teachers as they search for and locate appropriate learning objects
Pedagogical Issues	Participants still attempted to complete the visual aspects of the learning design prior to the pedagogical aspects.	DP 5: A system must direct teachers to the pedagogical aspects of the design process before the visual aspects of the design
Use of the Supporting Website	The supporting Website was again successful in provided the participants with information and direction.	DP 6: The use of a supporting website can aid teachers as they combine learning objects with learning designs
Flowchart Usage	A linear flowchart assisted the participants when creating a WebQuest Detailed steps with guiding questions which required critical analysis aided the participants as the created WebQuests.	DP 7: A system should be linear in design. DP 8: A system should actively engage the learner by developing and maintaining a shared goal. DP 9: A system should provide detailed steps with tailored assistance through cueing, prompting, questioning, modelling, telling and/or discussing. DP 10: A system should provide a deep approach to learning.
Template Usage	The participants reported they liked using the WebQuest templates and the templates assisted the participants to create WebQuests.	DP 11: A system should contain design templates

Table 4-19 shows the themes derived from research thus far, as well the associated design principles which specifically address these themes. The design principles will be used in Stage 4 of the research – the development of a web-based EPSS.

Stage 4: Design and Development of a Web-Based EPSS

This stage of the research study involved the three step development of a web-based Electronic Performance Support System (EPSS) designed to support teachers as they try to combine learning objects with learning designs. Stage 4.1 involved the development of the web-based EPSS, while Stage 4.2 involved a review of the EPSS by five experts working in the field of Learning Technologies development. The third and final part of Stage 4 involved the modification and refinement of the web-based EPSS in conjunction with the information gathered from the expert review.

Stage 4.1: Developing the Web-Based EPSS

This section of the results chapter presents and describes the web-based EPSS and discusses how the EPSS was constructed using the design principles generated by this research.

The underlying structure of the web-based EPSS focused on the three main components of the prototype EPSS; the flowchart, the templates and the supporting website; with the web-based EPSS integrating these three components into one progressive linear design. This process also addressed DP 6: *The use of a supporting website can aid teachers as they combine learning objects with learning designs*, DP 7: *A system should be linear in design*, and DP 11: *A system should contain design templates*. The layout of the web-based EPSS also followed the recommendations of a recent study by Woollard (2005) which emphasised the use of a pedagogical metaphoric theme throughout software designed for teacher education. The metaphor, used in the design of the web-based EPSS, was a jigsaw where teachers can 'Piece Together WebQuests'. This metaphor was selected because of the similarity of designing a WebQuest to completing a jigsaw – one creates each attribute of a WebQuest, and then pieces them into a whole, revealing the entire design.

The theme was emphasised through a jigsaw based navigation bar and through the use of the "Jigsaw Man", an icon which when selected provided guidance and help to the user. Screen shots of the web-based EPSS shown in Figure 4-17 and 4–18 display the pedagogic metaphoric theme, including the Jigsaw man, as well as the basic layout of the web-based EPSS.

Please see print copy for Figure 4.17

Figure 4-17 The introductory screen of the web-based EPSS

Please see print copy for Figure 4.18

Figure 4-18 The main welcome screen of the web-based EPSS, showing the standardised layout and jigsaw theme, including the Jigsaw Man in the centre of the screen

Figure 4-17 shows the screen the user sees when they visit the web-based EPSS for the first time. This introductory screen establishes the pedagogical metaphoric theme of piecing together a WebQuest. This page also directs the user to the main welcome page shown in Figure 4-18. The main welcome page sets the scene and gives detailed instructions on how the user can start piecing together a WebQuest. Figure 4-18 also shows the structure and layout of the EPSS which is kept consistent throughout. On the left hand side of the layout is the six piece navigational column, which is numbered to show the linear progression of the EPSS and is in the shape of jigsaw pieces to continue with the theme. Two buttons are also located above the navigational column, these buttons direct the user to examples of WebQuests and learning objects. The learning objects page can be seen in Figure 4-19.

Please see print copy for Figure 4.19

Figure 4-19 The learning objects page of the web-based EPSS, containing examples of learning objects and links to a learning object repository

The purpose of these links to examples of WebQuests and learning objects was to introduce the user to learning designs in the form of WebQuests and to the concept of learning objects and their repositories.

To begin piecing together a WebQuest the user must click on the on the first jigsaw piece on the navigational bar. This is made easier as the other five jigsaw buttons are only active after the previous step has been completed. A screen shot of this step can be seen in Figure 4-20.

Please see print copy for Figure 4.20

Figure 4-20 Step 1 of the EPSS, where users can view a series of templates or an exemplary example of a WebQuest using these templates

It is during Step 1 that the user is introduced to the topic of templates and the various types of WebQuests they can potentially create with the aid of the EPSS. This step has detailed instructions in the form of guiding questions which assist the user in selecting an appropriate template. These guiding questions are taken directly from the paper based flowchart created in Stage 2 of the research.

The next process in the EPSS, Step 2, involves the user selecting the actual WebQuest template they want to use and entering a title for their WebQuest. Whilst this may seem like a small progression from the user's point of view, it is a necessary step from a technical viewpoint, as the main variables for the EPSS are created and given values in this step. A screen capture of this step can be seen in Figure 4-21.

Please see print copy for Figure 4.21

Figure 4-21 The second step in the web-based EPSS

Figure 4-21 not only shows the simple process of entering a title for the user's WebQuest and selecting a template, but it also continues to display the consistency of the layout and structure of the EPSS.

The following step in the EPSS is Step 3.This multifaceted step involves two of the pedagogical aspects of the learning design, the Task and the Process, as well as the important undertaking of searching for appropriate learning objects. This interrelated approach was considered necessary as these three aspects of the learning design are so closely interconnected. That is to say that the success of the learning design depends largely on selecting a challenging cognitive task, where the process is clearly described and incorporates an appropriate learning object. Because of the close relationship of these parts of the learning design, this step of the EPSS was multifaceted where the user could move from the task to the process, or even search for appropriate learning objects with ease. This step of the EPSS also address DP 5: *A system must direct teachers to the pedagogical aspects of the design process before the visual aspects of the design.*

Screen shots of the start of Step 3 can be seen in Figure 4-22.

Please see print copy for Figure 4.22

Figure 4-22 The third step of the web-based EPSS showing how the system focuses on the pedagogical aspects of the design.

The entry page to Step 3 of the EPSS, shown in Figure 4-22, emphasises the importance of this step and the interconnectivity of three aspects incorporated in this step. The step also presents hyperlinks to more information about each of these aspects, including examples of the tasks, processes and learning objects used in a variety of working WebQuests. However, the main feature of the step occurs when a user clicks on either one of the jigsaw men. This action opens a separate window that enables the user to follow detailed instructions to design their task, create their processes or locate appropriate learning objects that can be combined with the learning design. An overview of the procedure can be seen in Figure 4-23.

Please see print copy for Figure 4.23

Figure 4-23 A text entry screen where the user replaces the detail instructions with their description of the their task

The pop up window shown in Figure 4-23 is activated when the user clicks on the Jigsaw man associated with the task shown in Figure 4-22. The other Jigsaw men shown in Figure 4-22 open similar windows, however the instructions are different depending on whether the jigsaw man is associated with the process or learning objects aspect. The detailed instructions also vary depending on what template was selected in Step 2 of the EPSS. In this situation the task aspect of a simulated diary is shown. This technique of having pop up windows that contain detailed instructions, which the user replaces with their own text addresses DP 9: *A system should provide detailed steps with tailored assistance cueing, modelling, telling and/or discussing*.

The procedure described above is very similar for the process aspect of the Step 3; however more information was given to the user when they needed to search for learning objects. This information included instructions on how to search for learning objects using the advanced search engines of the learning object repositories. The purpose of directing the user towards the advanced search engines was so that more learning object metadata could be searched, therefore increasing the users' chance of finding appropriate learning objects. The EPSS also linked to four learning object repositories, twice the number than the prototype EPSS, also increasing the chance of finding an appropriate learning object. An overview of these four learning object repositories can be seen in Table 4-20.

Table 4-20 An overview of the learning object repositories the web-based EPSS links to

Name	Description
EdNA – Online	EdNA Online is a service that aims to support and promote the benefits of the Internet for learning, education and training in Australia. It is organised around Australian curriculum (Education Network Australia, 2005).
MERLOT	Multimedia Educational Resource for Learning and Online Teaching (MERLOT) is a free and open learning object repository based in North America that is designed for educational staff and their students (Multimedia Educational Resource for Learning and Online Teaching, 2005).
NSDL	The National Science Digital Library (NSDL) is an educational resource site for science, technology, engineering and mathematics (National Science Foundation, 2000).
ALI	The Apple Learning Interchange (ALI) is a social network for educators which offers a broad range of learning objects on a wide variety of topics (Apple Learning Interchange, 2004).

The extra information given on how to search for learning objects, the use of advanced searching tools and the increase in the number of repositories made available to the participants all address DP 4: *A system must support teachers as they search for and locate appropriate learning objects*.

After completing all the aspects of Step 3; the task, the process and selecting appropriate learning objects; the fourth step in the EPSS is made active and the user can continue piecing together their WebQuest by moving through the fourth step.

The fourth step still has a pedagogical focus and involves the user modifying an assessment rubric so that it aligns with the user's task. As in the previous steps, help is given in the form of detailed instructions and exemplary examples. This step also makes use of a pop-up text box, similar to the one shown previously in Figure 4-23. In this box the user can enter text and modify the evaluation rubric. An outline of Step 4 can be seen in Figure 4-24.

Please see print copy for Figure 4.24

Figure 4-24 The fourth step of the EPSS focuses on another pedagogical element

As the user saves their evaluation and completes Step 4 the jigsaw piece indicating Step 5 in the navigational bar becomes active. It is during this next step that that EPSS focuses the user's attention towards the final aspects of the WebQuest: the introduction, conclusion, and the teacher's page. As in the previous steps, when the user clicks on the Jigsaw man associated with each component a pop up text box similar to Figure 4-23 opens. These text boxes once again contain detailed instructions on how to complete each aspect of the design. A screen shot of Step 5 can be seen in Figure 4-25.

Please see print copy for Figure 4.25

Figure 4-25 A screen shot of the fifth step of the EPSS

Once a user of the web-based EPSS has completed Step 5 they will have finished the content of the critical aspects of a WebQuest design. However there is still one more step in the web-based EPSS. The sixth and final step of the EPSS involves downloading the generated pages of the user's WebQuest to the user's computer. Again, detailed instructions informing the user of how to download each page of the generated WebQuest are given.

A screen shot of the step can be seen in Figure 4-26.

Please see print copy for Figure 4.26

Figure 4-26 A screen shot of the sixth and final stage of the EPSS

Once these instructions are completed the user will have a folder on their computer containing eight generated web pages correctly linked together to form a pedagogically sound learning design, in the form of a WebQuest, with the WebQuest incorporating learning objects. It is only when these generated web pages have been downloaded do the users get the opportunity to ‘polish and prettify’ (Dodge, 2004, p.1) their learning design. Detailed instructions on how to do this using Dreamweaver™, the same web editing software previously used in the research, as well as information on how to locate digital images from linked digital libraries are given after they have downloaded the eight generated web pages. Leaving this procedure of ‘polishing and prettifying’ to the end of the design process not only adds support to DP 5 *A system must direct teachers to the pedagogical aspects of the design process before the visual aspects of the design,* but also addresses DP 2, *A system should support teachers as they incorporate digital images into their learning designs.* It addresses DP 2 by providing detailed links to the tutorials used in the prototype EPSS and the digital image libraries, both of which were successful at alleviating issues participants faced in this area in previous stages of the research.

Summary of Stage 4.1

The purpose of this step was to develop a web-based EPSS that would assist teachers as they try to combine learning objects with learning designs. The EPSS was developed using the design principles generated by this study. An overview of how the EPSS addressed these design principles can be seen in Table 4-21.

Table 4-21 An outline of how the web-based EPSS addressed the design principles generated from this research

Design principles generated from this research	Features of the web-based EPSS that address the design principles
DP 1: A system should support teachers as they use web development tools	The overall structure of the EPSS requires the user to only need web development tools during the final step of ‘polishing and prettifying’ the design Online hyperlinks to tutorials provided to aid in this process
DP 2: A system should support teachers as they incorporate digital images into their learning designs	Hyperlinks to digital image libraries provided Online Dreamweaver tutorials provided
DP 3: A system must make best use of teachers’ time	The progressive linear design of the EPSS The detail instructions provided at each step The use of templates
DP 4: A system must support teachers as they search for and locate appropriate learning objects	Direct links to the advance searching tools of 4 learning object repositories Detailed instructions given on how to use the searching tools
DP 5: A system must direct teachers to the pedagogical aspects of the design process before the visual aspects of the design	The linear design of the EPSS forces users to the pedagogical aspects of the design process prior to the visual aspects.
DP 6: The use of a supporting website can aid teachers as they combine learning objects with learning designs	The entire EPSS is web based All hyperlinks from the successful prototype EPSS are integrated into the web-based EPSS
DP 7: A system should be linear in design.	The web-based EPSS is linear in design
DP 8: A system should actively engage the learner by developing and maintaining a shared goal.	The pedagogical metaphoric theme And the focus on a shared goal of completed a WebQuest
DP 9: A system should provide detailed steps with tailored assistance through cueing, prompting, questioning, modelling, telling and/or discussing.	Detailed instructions and prompts are given at every step of the design process Exemplary examples are given at each step
DP 10: A system should provide a deep approach to learning.	Users are required to critically examine the guiding questions, and use the answers to make links between the various pedagogical attributes of their WebQuest.
DP 11: A system should contain design templates	The five successful design templates from the prototype EPSS are integrated throughout the web-based EPSS

Having investigated and identified the issues that the participants faced, and then having designed and developed a prototype EPSS to address these issues, it was possible to move onto the next step of the research and have the web-based EPSS reviewed by experts.

Stage 4.2: Expert Review of the Web-Based EPSS

Expert reviews have been described as the life blood of the development process as they provide the opportunity to get feedback from specialists in the appropriate field about the workability of the processes underlying the new development (Reeves & Hedberg, 2003). The specific purpose of the expert review in this study was to find information about the workability of the processes involved in the web-based EPSS, with the intention of improving the EPSS through revision.

The web-based EPSS was reviewed by five professionals in the areas of instructional design and/or information technology (see Appendix J).The experts were asked to systematically review the web-based EPSS using the expert review sheet (see Appendix K). The results were collated and analysed with three main issues arising: hyperlink issues, incorrect spelling and grammar and insufficient depth in the process section. The prevalence of these issues can be seen in Table 4-22.

Table 4-22 The prevalence of issues arising from the expert review of the web-based prototype

Issues arising from the Expert Review	Number of Supporting Comments					
	Reviewer 1	Reviewer 2	Reviewer 3	Reviewer 4	Reviewer 5	**Total** [a]
1. Hyperlink Issues	29	31	25	23	19	**31**
2. Incorrect Grammar/Spelling	12	15	18	10	18	**18**
3. Insufficient Depth	1	1	0	1	0	**1**

[a] The total comment column is not the sum of the reviewers comments, but the total number of individual issues identified

The table indicates that of the three issues arising from the expert review, hyperlink issues were the prevalent problem the reviewers encountered. These included not only broken links to external sites, but also links appearing in new windows, leading to confusion. The table also indicates that the reviewers identified 18 grammatical and spelling errors, as well as showing that three out of the five reviewers had problems with the depth of one part of the prototype. Further investigation revealed that the reviewers found the “resources” section in step three of the prototype to be confusing and that clearer instructions were needed.

Apart from these issues the reviewers had a number of positive comments about the web-based prototype. These ranged from comments about the general structure of the prototype to the good selection of templates available, and from the clear easy to follow steps to the underlying metaphor of using a jigsaw to piece together a WebQuest.

Stage 4.3: Modification of the Web-Based EPSS

The purpose of this step of the research was to modify the EPSS based on the findings from the expert review. The recommended corrections and changes were largely typographical errors and issues relating to both external and internal hyperlinks, with the only major change being to the process section where clearer instructions were given. Once the modifications to the web-based EPSS were made, it was possible to move onto the next stage of the research and evaluate the EPSS.

Stage 5: Evaluation and Testing the Web-Based EPSS

Stage 5 of the research focussed on evaluating and testing the web-based EPSS. The purpose of this stage was to determine the effectiveness of the EPSS in supporting teachers as they tried to combine learning objects with learning designs. This purpose mirrored the third research question:

> *How do systems and supports address the issues teachers face as they combine learning objects with learning designs?*

To respond to this question, this section of the results chapter will present the data from the WebQuest evaluations as well as the analysis of the field notes, resources sheets, and interviews. Following this, the themes emerging from the data will be discussed.

Stage 5: Data Analysis

As in Stages 1 and 3 of the research, the first type of data to be analysed was the WebQuests created by the 16 participants and, as in the previous stages, these WebQuests were collected at the completion of the Workshop. Initially a researcher evaluation of these sixteen WebQuests was conducted with a descriptive overview of the results shown in Table 4-23 and a full evaluation given in Appendix O.

An observation to be made from the descriptive overview was that all 16 of the participants submitted their WebQuests for evaluation. This means that 100% of the participants had created a WebQuest that could be viewed with a web browser.

This 100% WebQuest submission rate is an improvement over both the previous workshops where only 46% of the participants in workshop series 1 and 66.7% in workshop series 2 submitted their WebQuests for evaluation. This substantial increase will be discussed in combination with other findings later in this section.

Table 4-23 A description of the WebQuests collected after the third workshop

Participant	Description
26	Title: Diet Related Diseases Focus: Ages 12 - 16 Description: In this WebQuest Students are requested to research a diet related disease and present their findings in a PowerPoint presentation. Level of Completion: 4/5 attributes commenced.
27	Title: Diet Related Diseases Focus: Ages 12 - 16 Description: This WebQuest is very similar to Participants 26's WebQuest as the two participants worked together, however this WebQuest is not as complete. Level of Completion: 1/5 attributes commenced.
28	Title: Shipwreck and Salvaging Focus: Ages 15 - 16 Description: In this partially completed WebQuest the structure and the mechanical aspects of the WebQuest are sound, however there is no content. Level of Completion: 0/5 attributes commenced.
29	Title: Government Focus: Ages 10 - 12 Description: In this WebQuest students in groups of three need to create and govern a small Kibbutz using the software package Sims Town™, and then describe the process. Level of Completion: 4/5 attributes commenced.
30	Title: What Spider is That? Focus: Ages 10 - 12 Description: A partially finished WebQuest where students have to complete a table on the appearance and habitat of two spiders. Level of Completion: 1/5 attributes commenced.
31	Title: Camp Barclough Focus: Ages 13 - 14 Description: In this partially completed WebQuest groups of students are requested to organise the safety and nutritional requirements for a two day school camp. Level of Completion: 5/5 attributes commenced.
32	Title: Shop till you Drop Focus: Ages 13 - 14 Description: This WebQuest requires students to manage a monthly budget. They have to buy food, clothes and pay bills, while recording and justifying their spending. Level of Completion: 1/5 attributes commenced.
33	Title: Design a Food Mall Focus: Ages 13 - 14 Description: This WebQuest revolves around researching food malls in Australia and looking at how they meet the needs of the shoppers, they must also create a signature dish. Level of Completion: 4/5 attributes commenced.

Table 4- 23 (cont.) A description of the WebQuests collected after the third workshop

34	Title: Bridges WebQuest Focus: Ages 15 - 16 Description: The Sydney Harbour Bridge is to be demolished in this WebQuest and students in groups of 3 have to design and justify a new iconic bridge for the city. Level of Completion: 2/5 attributes commenced.
35	Title: The Planet Mars Focus: Ages 13 - 14 Description: In pairs, students imagine they have been selected to go on a journey to Mars. The students have to research as much as possible before they go and present their findings. Level of Completion: 4/5 attributes commenced.
36	Title: IN4MUS Focus: Ages 13 - 14 Description: IN4MUS (inform us) is a WebQuest design for year eight technology students. The WebQuest guides them through the process of developing a web page. Level of Completion: 2/5 attributes commenced.
37	Title: Australia – You're Running Around it. Focus: Ages 10 - 12 Description: This WebQuest guides students through the process of collating the collective kilometres run during exercise time and plots them on a map of Australia Level of Completion: 3/5 attributes commenced.
38	Title: Video Camera Techniques Focus: Ages 13 - 14 Description: This WebQuest is aimed towards technology students in years seven and eight and it guides them through the process of making a movie of their choice. Level of Completion: 5/5 attributes commenced.
39	Title: A Day in the Life of a Fireman Focus: Ages 7 - 8 Description: This WebQuest gets students to imagine that they are volunteers for the local rural fire service, and they have to read a diary entry for a fiery summer's day. Level of Completion: 2/5 attributes commenced.
40	Title: Aussie Animals Extinct Focus: Ages 7 - 8 Description: In this WebQuest students assume they are members of the Protect Oz Animals Society and they have to create a presentation supporting an endangered species exhibition Level of Completion: 4/5 attributes commenced.
41	Title: Cooperating Communities WebQuest Focus: Ages 10 - 12 Description: In this WebQuest students imagine they work for a relocating company and they have to find the best home town in Australia and present their findings. Level of Completion: 4/5 attributes commenced.

Another observation to make from Table 4-23 is that the WebQuests created by Participants 26 and 27 were very similar, with both having the same title and Task, but Participant 26's WebQuest was closer to completion. Screen shots from these two WebQuests can be seen in Figure 4-27.

Please see print copy for Figure 4.27

Figure 4-27 Screen shots from Participant 26 and 27's WebQuests

The top two screen shots in Figure 4-27 clearly show similarities between the Home pages of Participant 26 and 27 WebQuests. Records from the field notes revealed that this similarity was largely due to the participants working together as they progressed through the first half of the web-based EPSS. This idea of collaboration emerges as a theme in this stage and will be explored later in the section after the evaluation of the WebQuests and the introduction of the qualitative data.

The screen shots shown in Figure 4-27 also reveal the final layout of WebQuests created with the aid of the EPSS. The title of the WebQuest is located in the top centre with an eight item navigation bar placed directly below. Underneath this is the main body of each page. This layout is consistent throughout the created WebQuests.

An evaluation of these two WebQuests and the other WebQuests from this stage was again conducted by the researcher. The full results of this evaluation are shown in Appendix O and an example showing the results from Participants 26's WebQuest can be seen in Table 4-24. As in the previous stages, the table is organised to show how the WebQuest Evaluation Rubric (Bellofatto et al., 2001) criteria was applied to the participants' WebQuests.

Table 4-24 The researcher evaluation of Participant 26's WebQuest

Please see print copy for Table 4.24

The researcher evaluation of Participant 26's WebQuest revealed that the participant had created all but the Evaluation attribute of a nutritional WebQuest. The WebQuest was found to be mechanically sound, although the overall aesthetics were hindered by the limited use of colour. In terms of pedagogy, the WebQuest's Introduction and Task were graded as being 75% and 80% respectively, however the Process attribute lacked teaching strategies and the researcher thought that more complex learning activities were needed. Overall the WebQuest achieved a total of 61% indicating that is was above average.

Along with this researcher evaluation, all the WebQuests were evaluated by the same two external evaluators used in stages 1 and 3. Their individual results were again compared with the results from the researcher evaluation. This comparison returned an inter-observer agreement of 85.8% which, as in the two previous evaluations, indicated that there was a high level of agreement between their scores. The mean scores from the evaluators were calculated for each item of the WebQuest evaluation. The results shown in Table 4-25.

Table 4-25 The mean scores from two external evaluations of the participant's WebQuests in Stage 5 of the research

		Participants							
		26	**27**	**28**	**29**	**30**	**31**	**32**	**33**
Overall Aesthetics	Visual Appeal /4	2	2	2	2	2	4	2	3
	Navigation /4	2	2	4	4	2	4	4	4
	Mechanical Aspects /2	2	2	2	2	2	2	2	2
	Sub-Total /10	**6**	**6**	**8**	**8**	**6**	**10**	**8**	**9**
Introduction (Learning Supports)	Motivational Effectiveness /2	2	n/c	n/c	2	n/c	2	n/c	2
	Cognitive Effectiveness /2	1	n/c	n/c	2	n/c	2	n/c	2
	Sub-Total /4	**3**	n/c	n/c	**4**	n/c	**4**	n/c	**4**
Task (Learning Tasks)	Connection of Tasks to Standards /4	2	2	n/c	2	2	2	n/c	2
	Cognitive Level of Tasks /6	6	6	n/c	6	3	6	n/c	3
	Sub-Total /10	**8**	**8**	n/c	**8**	**5**	**8**	n/c	**5**
Process (Learning Supports)	Clarity of Process /4	2	n/c	n/c	4	n/c	2	n/c	2
	Scaffolding of Process /6	3	n/c	n/c	0	n/c	3	n/c	3
	Richness of Process /2	1	n/c	n/c	2	n/c	1	n/c	1
	Sub-Total /12	**6**	n/c	**n/c**	**6**	**n/c**	**6**	**n/c**	**6**
Resources (Learning Objects)	Relevance & Quantity of Resources /4	2	n/c	n/c	2	n/c	2	n/c	2
	Quality of Resources / 4	2	n/c	n/c	2	n/c	2	n/c	2
	Sub-Total /8	**4**	**n/c**	**n/c**	**4**	**n/c**	**4**	**n/c**	**4**
Evaluation (Learning Supports)	Clarity of Evaluation /6	**n/c**	**n/c**	**n/c**	**n/c**	**n/c**	**3**	**3**	**n/c**
TOTAL (%)	**includes only attributes commenced**	**61**	**70**	**80**	**68**	**55**	**70**	**63**	**63**

(N.B. A higher number represents a better result)

n/c = Indicates that the participants did not commence that section

Table 4-25 (cont.) The mean scores from two external evaluations of the participant's WebQuests in Stage 5 of the research

		Participant							
		34	**35**	**36**	**37**	**38**	**39**	**40**	**41**
Overall Aesthetics	Visual Appeal /4	2	2	2	2	4	2	2	2
	Navigation /4	2	4	2	2	4	4	4	4
	Mechanical Aspects /2	2	2	2	2	2	2	2	2
	Sub-Total /10	**6**	**8**	**6**	**6**	**10**	**8**	**8**	**8**
Introduction (Learning Supports)	Motivational Effectiveness /2	n/c	1	n/c	n/c	2	n/c	1	1
	Cognitive Effectiveness /2	n/c	1	n/c	n/c	2	n/c	1	1
	Sub-Total /4	n/c	**2**	n/c	n/c	**4**	n/c	**2**	**2**
Task (Learning Tasks)	Connection of Tasks to Standards /4	2	2	2	2	2	2	2	2
	Cognitive Level of Tasks /6	3	4	3	6	3	3	3	3
	Sub-Total /10	**5**	**6**	**5**	**8**	**5**	**5**	**5**	**5**
Process (Learning Supports)	Clarity of Process /4	4	4	4	2	2	2	4	2
	Scaffolding of Process /6	3	3	3	3	3	3	3	3
	Richness of Process /2	1	1	0	1	1	0	1	1
	Sub-Total /12	**8**	**8**	**7**	**6**	**6**	**5**	**8**	**6**
Resources (Learning Objects)	Relevance & Quantity of Resources /4	n/c	2	n/c	2	2	n/c	2	n/c
	Quality of Resources / 4	n/c	2	n/c	2	2	n/c	2	n/c
	Sub-Total /8	**n/c**	**4**	**n/c**	**4**	**4**	**n/c**	**4**	**n/c**
Evaluation (Learning Supports)	Clarity of Evaluation /6	**n/c**	**n/c**	**n/c**	**n/c**	**4**	**n/c**	**n/c**	**3**
TOTAL (%)	**includes only attributes commenced**	**59**	**65**	**56**	**60**	**65**	**56**	**61**	**57**

(N.B. A higher number represents a better result)

n/c = Indicates that the participants did not commence that section

An observation to make from the WebQuest evaluations presented in Table 4-25 is that 100% of the participants were able to create WebQuests where the mechanical aspects were assessed as being perfect, i.e., no broken links, badly sized tables or misplaced images were encountered (Bellofatto et al., 2001). This point was also highlighted with the evaluation of the navigation aspects, where the reviewers said that 10 out of the 16 participants had created WebQuests where the navigation appeared seamless, with only one or two errors being reported in the other six WebQuests. These findings led to the success of the web-based EPSS as a way of aiding users to create mechanically and navigationally sound WebQuests.

Quantitative data from Stages 3 and 5 of the research enabled comparisons to be made. An overview of these comparisons can be seen in Table 4-26.

Table 4-26 Comparisons between the WebQuest evaluations from workshop series 2 and workshop series 3

	Workshop Series 2 n=8	**Workshop Series 3 n=16**
Overall Aesthetics /10	7.75	7.68
Introduction /4 (Learning Supports)	2.75	3.12
Task /10 (Learning Tasks)	4.75	6.14
Process /12 (Learning Supports)	7.38	6.50
Resources /8 (Learning Resources)	4.00	4.00
Evaluation /6 (Learning Supports)	2.57	3.25
TOTAL (%) [a]	**57.75**	**63.06**

[a] The total only includes attributes commenced

A preliminary observation to make from the data displayed in Table 4-26 is the positive increase in the total evaluations of the WebQuests created with the aid of the web-based

EPSS, when compared to those created with the prototype EPSS in workshop series 2. While the significance of this increase was not realised, descriptive trends do favour the use of the web-based EPSS. Particularly considering 100% of the participants submitted their WebQuest for review in workshop 3, compared to only 66.7% in second series of workshops.

A breakdown of this increase in the total reveals that the WebQuests created with the aid of the web-based EPSS achieved higher results in only the introduction, task and evaluation sections, with exactly the same results being achieved in the resources section. The table also reveals that WebQuests created with the aid of the web-based EPSS actually achieved slightly lower results in the overall aesthetics and the process sections. However, again given the fact that 100% of the WebQuests were submitted after the third workshop, compared with only 66.7% after the second, the initials benefits of the web-based EPSS can be seen. Further discussion on this and other issues relating to the formal evaluation and comparison will be discussed in conjunction with the qualitative data.

The qualitative data in this stage of the research was again analysed in a similar fashion to Stages 1 and 3, however this time the individual comments were coded into the broad category: issues participants faced using the web-based EPSS, with this category being determined by the first research question. As in Stages 1 and 3 trends in the data began to emerge and from these trends three themes resurfaced: *Time Limitations, Resource Collection and Pedagogical Issues*. Along with two new themes which appeared for the first time: *Web-Based EPSS Usage and Suggested Modifications,* and *Collaborations.* The number of individual comments relating to each of the themes can be seen in Table 4-27.

Table 4-27 The prevalence of themes derived from the data collected during Stage 5

Major Themes	Sub-Themes	Number of Supporting Comments from the Data			
		Field Notes	Resources Sheets	Interviews	**Total**
1. Time Limitations	-	6	8	5	**19**
2. Resource Collection	-	2	10	5	**17**
3. Pedagogical Issues	-	-	-	5	**5**
4. Web-Based EPSS Usage and Suggested Modifications	-	4	-	13	**17**
5. Collaborations	-	3	2	3	**8**

Table 4-27 shows that of the five themes derived from the data collected in this stage of the research, time limitations was the most prevalent issue the participants faced as they used the web-based EPSS to combine learning objects with learning design. This was closely followed by resource collection, with the two new themes of web-based EPSS usage and suggested modifications and collaborations also appearing in significant numbers. These themes and the trends from the quantitative data are discussed below:

Theme 1: Time Limitations

The theme of time limitations, as in Stages 1 and 3, referred to the issues and concerns the participants had with the amount of time it was taking to create a learning design in the form of a WebQuest. Furthermore, as in Stages 1 and 3 this theme was also heavily supported by the qualitative data collected in Stage 5, with 19 individual comments being recorded across the three sources of data.

Closer examination of these individual comments revealed that the actual workshop, which was scheduled to be eight hours in duration, due to the participants arriving late and leaving early, was reduced to six hours. This meant that this final workshop was two hours less than the series of workshops conducted in Stages 1 and 3 of the research. Taking this into consideration trends in the data still indicate that the participants had problems managing the time needed to create their learning design. This was evident in the resources sheets where 30% (n=5) of the participants indicated that they selected their resources quickly because, as Participant 37 stated, "… it was the first one I came across and I didn't want to waste anymore time on it…" This typical response from the resources sheets was also supported during the post workshop interviews, where Participant 32 pointed out that she "…didn't want to waste time searching for those learning things (objects)…" as she wanted to finish her learning design.

While these comments do indicate that the participants had issues managing their time, the comments are also closely related to theme 2, resource collection.

Theme 2: Resource Collection

The theme of resource collection also resurfaced for the third time. This theme again referred to the issues the participants had searching for, identifying and evaluating appropriate learning objects. Once again this theme was heavily supported across all data sources. This was especially so in the WebQuest evaluations where, as in Stage 3, no learning objects from the given repositories were used in the participants' learning designs. Instead the participants elected to use basic informative websites. When questioned about this issue in the post workshop interviews, one participant (Participant 36) claimed that they did not realise that they had to include a learning object, while another three participants thought that they would add one later as they could not find a suitable learning object from the repositories straight away. Despite this absence occurring 4 out of the 5 interviewees (Participants 29, 34, 35, and 40) were still able to achieve average or above average marks for the task and processes components of the learning design. An overview of Participant 29's learning design displaying this occurrence can be seen in Figure 4-28.

Please see print copy for Figure 4.28

Figure 4-28 Participant 29's Learning Design created with the aid of the web-based EPSS

This series of screen shots displays the consistent navigational structure of a Participant 29’s WebQuest. The introduction was seen by the evaluators to be motivating and above average, as was the task which involved constructing and governing a Kibbutz community using the award winning computer game Sim Town (Maxis Software, 1995). The game structure of Sim Town involves students crafting a small town. The students are allocated a blank section of land and are required to place homes, workplaces, and civic building on it, with the primary objective been to keep the residents of Sim Town happy, by meeting their needs. This task and subsequent process was seen by the WebQuest evaluators to be lacking in strategy, although it still achieved an average score. Figure 4-28 also shows that the evaluation section was not commenced, as the interviews revealed that the participant did not have enough time to complete it. What is interesting about this WebQuest is that the participant used a decade old computer game, Sim Town as the only resource, despite more modern and just as applicable learning objects being available. This matter also highlights issues with the design of the web-based EPSS, as the participants could move on past Step 3 of the EPSS without selecting a learning object. Further investigation revealed that just by entering text into the pop up box associated with this step allowed the participants access the next step of the EPSS.

Theme 3: Pedagogical Issues

The original theme was again associated with the pedagogical approaches of the learning design. While not heavily supported in the qualitative data, with only five comments being recorded during the post workshop interviews, evidence supporting this theme came from the evaluations of the participants' WebQuests. The evaluation revealed that the pedagogical attributes of the WebQuests: the Introduction, Task, Process and Evaluation received on average scores of 78%, 61%, 54% and 54% respectively. This is despite the participants being trained and qualified teachers with an average of over 16 years teaching experience.

Further investigation of these declining and relatively low scores revealed that the Evaluators thought that the participants' Introduction lacked either motivational or cognitive effectiveness and that over half of the participants' Tasks were limited in their significance to the students' lives and simply involved collating information from several sources. The further investigation also revealed that the participants' Processes were deemed by the evaluators to be explained clearly, but that the Processes often did not specifically relate to accomplishing the task. An example of this can be seen in Participant's 33 WebQuest shown in Figure 4-29.

Please see print copy for Figure 4.29

Figure 4-29 Screen shots of pedagogical attributes of Participant 33's WebQuest

The screen shots shown in Figure 4-29 display the pedagogical aspects of Participant 33's WebQuest. These screen shots show an engaging and effective Introduction, and a Task that was feasible, but not obviously connected to local Education Department standards, or even precisely related to the Introduction. The evaluators thought that the even though simple directions were given in the Process, the directions did not provide sufficient details to solve the task. The final observation to make from Figure 4-29 is that Participant 23 did not start working on the Evaluation Attribute as the structure given in the template is presented. When questioned about these factors in the post workshop interview Participant 23 responded that she "… just completed these sections quickly as [she] wanted to finish and make it look good". This comment, and other similar comments from the post workshop interviews, all add support to the pedagogical issues faced by the participants as they combined learning objects with learning designs.

These comments also indicate a strong relationship between the pedagogical issues and the issue of Time Limitations.

Theme 4: Web-Based EPSS Usage and Possible Modifications

The new theme of web-based EPSS usage refers to any comments made in the data relating to the participants' use of the web-based EPSS. The main emphasis of this theme was that all 16 of the participants used the web-based EPSS to create a learning design in the form of a WebQuest. Evidence of this came initially from the field notes, where Observer 1 recorded that during the first hour of the workshop "… all the teachers (participants) are using the website" (the web-based EPSS). This finding was supported during the post workshop interviews where 13 individual comments referring to the interviewees' use of the EPSS were recorded. However, concrete evidence of this theme came from the WebQuest evaluations where it was revealed that all 16 of the participants in this stage of the research created a mechanically sound WebQuest based on the templates that were integrated into the web-based EPSS. Screen shots of four of these WebQuests that indicate this can be seen in Figure 4-30.

Please see print copy for Figure 4.30

Figure 4-30 Screen shots of various WebQuests created using the web-based EPSS

Figure 4-30 displays the task section of four of the participants' WebQuests. An initial observation to make from these screen shots shown above is that they all have the same layout, a title, a navigation bar and a description of the task. This layout was provided by the web-based EPSS through the use of the integrated templates.

With 100% of the participants using the web-based EPSS to combine learning objects with learning designs, the technical features of the EPSS were fully tested, with only one minor programming error appearing. This error was identified by both of the observers and in the post workshop interviews. The error became apparent when the participants used punctuation marks in the title of their WebQuests, for example "Wayne's World" where an apostrophe is used. This example, through errors in the server side multiple regression code, would return the following title "Wayne's

World”. This issue caused insignificant problems during the workshop with one participant saying “I laughed at the mistake in the title, but I just re-entered the title leaving out the apostrophe and continued on” (Participant 39).

The analysis of the data, particularly the post workshop interviews, also revealed three possible modifications to the web-based EPSS to make the process of combining learning objects with learning designs more complete. These suggested modifications included:

1. *A greater ability to switch between help screens and pop up text boxes.* This suggestion had support from both of the observers and 100% (n=5) of the participants in the post workshop interviews. It indicated that the participants wanted to be able to view the help screens while entering text into the pop up text boxes.

2. *A greater ability to incorporate graphics and add a colour theme to the WebQuest.* This suggested modification became apparent during the post workshop interviews where 60% (n=3) of the interviewees pointed out that it would have been more time efficient to be able to select a colour theme and simple graphics prior to downloading the WebQuest pages in Step 6 of the web-based EPSS. This suggestion, whilst not specifically supported elsewhere in the data, did gain some support from a more in depth look at the participants’ WebQuests. This investigation revealed that while the overall aesthetics of the WebQuests created in Stage 3 and Stage 5 were not significantly different (P>.05), the visual aspects of the WebQuests generated with the aid of the web-based EPSS scored significantly lower (p>0.5) than the WebQuests created in the previous stage.

3. *An all encompassing download feature.* Both of the observers noted that the participants appeared “confused” as they attempted to download the individual pages of their generated WebQuests. These observations were heavily supported during the post workshop interviews where 100% (n=5) indicated that the download process was laborious, with Participant 32 suggesting that the process could be simplified by downloading one compressed file that contained all of the generated WebQuest pages and images.

A final aspect of this theme that was revealed during the post workshop interviews was that all 5 of the interviewees commented on how much they enjoyed working through the web-based EPSS. Participant 31 went as far as stating the she “felt thrilled” each time she completed a section and was told by the jigsaw man to move on to the next.

Theme 5: Collaborations

The last theme to emerge from the data was collaborations. This theme referred to any issues the participants had that related to actively working together with their peers to create a WebQuest. This theme was supported in the qualitative data, with only eight individual comments being recorded of the participants working in groups to create a WebQuest, with the first instance being recorded by Observer 1 when he noted that “many of the teachers (participants) are working in pairs”. A small amount of evidence supporting this came from the post workshop interviews where three different participants indicated that they worked together with the person sitting next to them, creating one main WebQuest, although submitting two to be evaluated, even though one WebQuest was little more than an outline. These observations lead to a deeper analysis of the WebQuest evaluations, with subsequent findings indicating that approximately every second WebQuest that was evaluated in this stage of the research contained a number of aspects that were yet to be commenced. This can be seen in Table 4-25 where the ‘n/c’ (not yet commenced) abbreviations line up in columns and occur almost alternatively throughout the table. This suggested that approximately every second participant just generated, downloaded and submitted the outline of a WebQuest, and worked collaboratively with the person next to them creating just one complete WebQuest between them.

Stage 5: Summary

The purpose of this stage of the research was to evaluate and test the web-based EPSS. Due to unforeseen circumstances the evaluation and testing was completed during a shortened six hour workshop. Once again the data was collected via field notes, resources sheets, interviews and WebQuest evaluations. An analysis of the data revealed several trends, and from these trends four main themes emerged. A summary of these themes can be seen below in Table 4-28.

Table 4-28 An outline of the themes identified from Stage 5 of the research

Themes identifying the issues that the participants faced	Summary of information relating to the themes
Time Limitations	Unforseen circumstance saw the workshop shorten by 2 hours. The participants still had problems managing their time.
Resources Collection	Not a single learning object from the four given repositories was utilised.
Pedagogical Issues	Despite the participants averaging over 15 years teaching experience, the pedagogical aspects of their WebQuests achieved on average only 64% in the WebQuest Evaluations.
Web-Based EPSS Usage and Suggested Modifications	All the participants used the web-based EPSS. All participants create a mechanical sound WebQuest. Minor technical problems in the multiple regression code limited the use of punctuation characters in the WebQuests. The following modifications were suggested: • Greater ability to switch between help screens and pop up text boxes. • Greater ability to incorporate graphics and a colour theme to the WebQuest. • An all encompassing download feature.
Collaborations	Participations naturally formed partnerships and worked together in pairs to created higher scoring WebQuests.

Stage 6: The Final Refinement of the Design Principles

This final stage of the research process directly relates to research question 2:

2. *What design principles guide the development of systems and supports which assist teachers as they combine learning objects with learning designs?*

To attend to this question, this section of the results chapter will state a design principle in the form of a heuristic statement. Each statement will then be discussed in terms of its evolution.

DP 1: A system should be capable of completely generating the specific pages of a learning design.

This design principle has evolved from the previous DP 1: *A system should support teachers as they use web development tools*. With the older DP stemming from the issues the teachers had using web development tools in Stages 1 and 3 of the research. Specifically, these issues related to the folder and file structure associated with WebQuests, using the Site Definition Wizard provided by Dreamweaver™, creating hyperlinks and using tables to define the layout of a web page. This DP aims to alleviate these issues by suggesting that any system developed to aid teachers as they combine learning objects with (a web-based) learning designs should be capable of generating all of the web pages. This would avoid the need for teachers to use a web development tool, like Dreamweaver™, and therefore alleviating any issues associated with the web development tool.

DP 2: A system should enable teachers to add an appropriate thematic style and graphics to the learning design.

This refined DP is based on the previous DP 2: *A system should support teachers as they incorporate digital images into their learning designs.* The refined version of this DP indicates that any system which is developed to assist teachers as they try to combine learning objects with learning designs should have the ability to scaffold teachers through the process of applying appropriate thematic styles and graphics. This slight change in focus incorporates the previous version of the DP as well as providing support for issues identified in Stage 5 of the research. The support should enable teachers to select and change a colour theme for their learning design, as well as allow teachers to easily add graphics which have been specifically created for web pages, thus alleviate the issues associated with image manipulation and to a lesser extent web development tools.

DP 3: A system must make best use of teachers' time.

This DP has remained virtually unchanged throughout the research, as data throughout the research project has constantly indicated that teachers had problems managing the time needed to create a learning design that made use of learning objects. This finding is supported by studies which also suggest that teachers have time management issues when using new technologies (Freebody, 2005; Smerdon et al., 2000). This DP addresses this issue and clearly suggests that any system which is developed to support teachers as they combine learning objects with learning designs must make best use of the teachers' time.

DP 4: A system must support teachers as they search for and locate appropriate learning objects.

This strongly stated DP has remained unchanged in the final version. It is specifically designed to meet the issues that the teachers had with locating and selecting appropriate learning objects to be used to their learning designs. The DP indicates that a support system should direct teachers towards the search engines of appropriate learning object repositories, thus allowing the metadata attached to the learning objects to be explored and searched. The DP also suggests that clear, detailed instructions on how to search the repositories should be given.

DP 5: A system must direct teachers to the pedagogical aspects of the design process before the visual aspects of the design.

The importance of this design principle was evident throughout the research, where the data revealed that without direction the participants focused their time and skills on the visual aspects of the learning design and often not leaving time, or rushing to complete, the pedagogical aspects of the design. To overcome this issue DP 5 focuses on scaffolding the pedagogical aspects of the learning design prior to the visual aspects. This DP is also supported by Bernie Dodge (2004), the creator of WebQuests, who directs designers towards the pedagogical attributes of a WebQuest before “polishing and prettifying” the design.

DP 6: The use of a supporting website can aid teachers as they combine learning objects with learning designs.

This DP aimed to support teachers as they combined learning objects with learning designs by providing hyperlinks to helpful websites. The overriding success of the supporting website outlined by the data analysis in Stage 3 of the research indicated the success of this DP. It should be noted that this DP could be made redundant by incorporating the supporting website into the actual design of the support system. This occurred successfully in Stage 5 of the research.

DP 7: A system should be linear in design.

Design principle 7 is grounded in literature (Cole et al., 1997; Villachica & Stone, 1999) on the topic of EPSS development and also based on the success of the linear systems designed and evaluated in this research project. The principle suggests that a system which is developed to support teachers as they combine learning objects with learning designs should be linear, that is, it should have a definite starting point which is followed with a progression of steps that lead to a distinct end point.

DP 8: A system should actively engage the learner by developing and maintaining a shared goal.

This DP is based on a corresponding guideline that was implemented earlier in this stage of the research. The initial guideline was derived from an extensive review of the literature relating to scaffolding learning experiences (Hogan & Pressley, 1997) and on literature surrounding computer-based cognitive tools (Jonassen, 1994; Kennedy & McNaught, 2001). The DP suggests that a system designed to aid teachers as they combined learning objects with learning designs should engage the teachers by developing and maintaining a shared goal – the development of a learning design which incorporates learning objects in this case.

DP 9: A system should provide detailed steps with tailored assistance through cueing, prompting, questioning, modelling, telling and/or discussing.

This DP indicates that all instructions given to teachers as they try to combine learning objects with learning designs should be described in detail, and where possible tailored assistance should be given. The foundations of this DP are grounded in the field of scaffolding (Hogan & Pressley, 1997)and instructional design (Avison & Wood-Harper, 1990). This DP is also heavily supported by data from this research, where it was revealed that participants who followed the detail instructions, cues and prompts given in EPSS created stronger learning designs than those who did not.

DP 10: A system should provide a deep approach to learning.

This DP has remained unchanged since it was introduced as a guideline in Stage 2 of the research. Its foundations are grounded in the literature relating to scaffolding (Hogan & Pressley, 1997) and on literature surrounding computer-based cognitive tools (Jonassen, 1994; Kennedy & McNaught, 2001). The DP suggests that a system designed to support teachers as they combine learning objects with learning designs should provide opportunities for the teachers to critically examine appropriate information and resources and make links between these and the various pedagogical attributes of a learning design. By working through this process it is believed (Biggs, 1999; Entwistle 1988; Ramsden, 1992) that learners can develop a higher level of competence.

DP 11: A system should incorporate learning design templates.

This final design principle suggests that a system designed to support teachers as they combine learning objects with learning designs should incorporate a variety of design templates that can be easily modified by its users. This DP was heavily supported throughout this research project with analyses of the data clearly revealing that participants who used design templates had greater success at developing mechanically sound and pedagogically strong learning designs than those participants who did not used templates.

These 11 design principles were created and continually refined throughout the six stages of this development research study. They were grounded in literature and informed by issues that K-12 teachers encountered as they combined learning objects with learning designs, and by the evaluation of the learning designs the K-12 teachers created during this study.

This third evolution of the design principles brings to a close the final iteration of the development research approach conducted in this study. It is these designs principles, along with the other outcomes of the study, which will be explored in the following chapter.

CHAPTER 5

Conclusions

This chapter begins with a summary of the study and a discussion of the results in relation to the findings from the research, before concluding with a list of recommendations for further research.

Summary of the Study

This study set out to explore if a system could be designed and developed to support the pedagogical use of learning objects in the school environment. Specifically, it was theorised that a cognitive tool, in the form of an electronic performance support system (EPSS), could provide the necessary scaffolding to aid K-12 teachers through the process of combining learning objects within a specific learning design framework.

The study addressed the following three research questions:

1. *What are the issues that teachers face as they combine learning objects with learning designs?*
2. *What design principles guide the development of systems and supports which assist teachers as they combine learning objects with learning designs?*
3. *How do systems and supports address the issues teachers face as they combine learning objects with learning designs?*

The research approach selected to investigate these questions was based on Reeves' (2000) development research model. This model was implemented because it provided an approach to solving complex educational problems based on existing theory and current practice, while at the same time maintaining rigour due to its commitment to theory construction and explanation (Reeves et al., 2004). The cyclic nature of Reeves' model required the study to be conducted in six stages. These six stages were designed specifically to address the three research questions in a logical and sequential manner. An overview of this process is provided in Table 5-1. The table illustrates the six stages of the research project, as well as an outline of the major findings associated with each stage.

In Stage 1 the initial needs analysis revealed that the participants experienced issues in the following areas: *Technological Competency, Time Limitations, Resource Collection and Pedagogical Issues.* Using these issues in conjunction with current literature a series of design principles were constructed. Stage 2 involved implementing these design principles to create a prototype EPSS. Stage 3 comprised of: 1): evaluating and testing the prototype EPSS; 2) continuing the needs analysis started in Stage 1, and 3) refining the design principles to further guide the future development of the EPSS. This stage addressed all three research questions. Descriptive trends, derived from an analysis of the quantitative data collected in this stage, indicate a higher standard of WebQuests created with the aid of the prototype EPSS, compared to those created without it in Stage 1. The final phase of Stage 3 involved refining the design principles based on all the data collated and analysed thus far in the study. These design principles informed by Stage 4 of the research, were the principles that were applied to develop a web-based EPSS.

The fifth stage of the research was concerned with testing and evaluating the web-based EPSS. The results revealed that even though teachers were aided by the web-based EPSS to help them combine learning objects with learning designs, they had concerns about time limitations and about locating and collecting appropriate resources. Stage 5 also revealed that the teachers liked and felt capable of using the web-based EPSS to develop pedagogically sound teaching and learning experiences.

The last stage outlined in Table 5-1 is Stage 6. This stage involved the final refinement of the design principles and was informed by the complete findings of the study i.e., findings from the original needs analysis, the results from the evaluation and testing of the prototype EPSS, the continued needs analysis and the evaluation and testing of the web-based EPSS.

Table 5-1 An overview of the research process undertaken in the project

Stage	Research Question	Description of Stage	Outcomes
		Workshop Series 1	
1	1	Needs analysis	Participants had issues concerning: · Technological competency · Time limitations · Resource collection · Pedagogical issues
	2	Creation of design principles	The creation of 6 design principles
2	-	Development of a prototype EPSS	A Prototype EPSS
		Workshop Series 2	
3	1	Evaluation and testing of the prototype EPSS	Elements of the prototype EPSS found to reduce issues concerning: · Technological competency · Time limitations · Resource collection · Pedagogical issues
	2	Continuing the needs analysis	No new issues revealed
	3	Refining the design principles	Refinement of the 6 original design principle and the addition of 5 new design principles
4	-	Development of web-based EPSS	A web-based EPSS
		Expert Review of web-based EPSS	Positive comments made about the structure of the web-based EPSS
		Modification of the web-based EPSS	An expert reviewed EPSS which has foundations in theory and current practices.
		Workshop 3	
5	3	Evaluation of web-based EPSS	Elements of the web-based EPSS found to reduce and/or eliminate issues concerning: · Technological competency · Time limitations · Resource collection · Pedagogical issues A theme of working collaboratively appeared
6	2	Final refinement of the design principles	The production of 11 design principles

Outcomes Drawn from the Research

This section focuses on conclusions drawn from findings related to the research questions. It presents the issues that participants faced as they combined learning objects with learning designs and discusses the theoretical implications associated with these issues. Areas for future research stemming from this process are also highlighted.

A point to consider prior to this discussion is that the participants in this study had similar profiles to the overall teaching population of Australia. The mean age of teachers in Australia is 43 (Australian Bureau of Statistics, 2005) and the mean age of participants in this study was 43. The percentage of female participants in this study was 70%, which is also representative of the general Australian teaching population, where 68% of all teachers are female (Australian Bureau of Statistics, 2005). The ways in which the participants used computer based resources prior to this study was also indicative of the current practices of a wider range of teachers. The majority of participants in this study reported that they use technology to research and present information. An international study by Kozma (2003) had similar findings, with teachers from 28 countries revealing that they mainly used technology to research for, or present information. These comparisons are important as they suggest that the convenient sample drawn from a limited geographical region in this study were representative of the demographics and behaviour of teachers on a broader scale, therefore indicating that the findings of this study may be applicable to teachers in general. However caution needs to be exercised in making such interpretations and a larger, more widespread sample would be needed to justify such a claim.

Issue 1: Technological Competency

At the start of each series of workshops all of the teachers were asked to complete a General Information Questionnaire (see Appendix D). Questions 6 and 7 of this questionnaire related to the participants' comfort level when using a computer and their previous experience of developing web pages. All of the participants responded to these questions and 90% indicated that they were comfortable or very comfortable using computers and 61% indicated that they have an intermediate or above skill level in developing web pages. Despite these high self-reported results, a major issue that the participants faced, particularly in the early stages of the research, related to their competency in the use of web development tools and in manipulating digital images.

Specifically, the participants had difficulties using the web development tool to design and construct the layout and structure of their WebQuests. These difficulties often related to the participants knowing when and how to use either the fixed or variable width feature of Hypertext Mark-up Language (HTML) tables. The participants also had issues using the web development tool to save and store their WebQuests, and often used the incorrect folder and file layout, resulting in their designs not working. The final web development issue concerned the use of absolute hyperlinks as opposed to relative links. Participants were not sure when to use the full uniform resource locator (URL) address or the relative URL. The other technological issue related to the ability of the participants to manipulate digital images. In particular the participants had problems compressing, transforming and/or reducing the scale of images so that they would be more visually appealing in their learning design.

The issues relating to the use of hyperlinks and the manipulation of images, which in many instances were learning objects, is of particular interest to this study especially considering one of the three characteristics of learning objects – reusability. This characteristic relies on teachers being able to reuse and share learning objects, which in many instances could involve the use of hyperlinks and/or slight manipulation of learning objects. Identifying that teachers have issues with these tasks exemplified the need for a support system.

Literature reviewed at the start of the of this project (Lajoie, 2000) suggested that an EPSS in the form of a cognitive tool has the ability to allow users to engage in activities that would otherwise be out of their reach e.g., web development and the manipulation of images. The EPSS designed and developed in this project successfully achieved this by sharing the cognitive load the participants face and supporting the cognitive process that the participants worked through. This sharing and support came in various forms, including the provision of a range of pedagogically effective learning design taxonomies, in the form of WebQuest templates. These templates provided the basic structure of the WebQuest and an easily modifiable pedagogical task, thus reducing the need for the participants to create HTML tables and reducing the amount of new hyperlinks needed. Further supports for the issues of image manipulation and web development were also provided via a variety of online tutorials. The tutorials covered a range of topics that were specifically selected to provide support for the lower level cognitive skills involved web in development and image manipulation, thus enabling the participants to focus on the higher level cognitive tasks involved in the development process i.e., designing the process their students should follow to complete the WebQuest.

The results given in Chapter 4 show that a web-based cognitive tool, in the form of an EPSS, can successfully address the technological issues faced by teachers as they combine learning objects with learning designs. This finding adds to the body of evidence that demonstrates the ability of an EPSS to guide, or scaffold, a user as they perform tasks that would otherwise be beyond the scope of their current capability.

Issue 2: Time Limitations

Another common problem the participants faced, as they combined learning objects with learning designs, related to the time taken to create a pedagogically effective learning experience. This issue emerged across all types of data and throughout all three stages of the research. The issue was addressed by the support system in two ways. Firstly, through the actual time saving design and content of the system, which included a variety of support mechanisms (online tutorials, digital image libraries, repository search engines, etc) being made available to the participants when required. Secondly, through the use of specific learning design taxonomies (i.e., WebQuest templates) which were incorporated into the web-based EPSS. The templates not only reduced the time required to create a learning design by providing a pre-made structure and layout of a WebQuest, but they also provided the pedagogy underlying the design. This pedagogical aspect will be discussed more in Issue 4.

An interesting finding relating to the issue of time limitations was that despite the substantial increase in amount of support offered by the web-based EPSS and the fact that all of the participants had created a WebQuest that could be viewed in a web browser, the participants were still concerned about the amount of time it was taking to create a WebQuest.

This issue is closely related to findings identified by Freebody (2005) when he conducted a Pilot Field Review of the implementation of learning objects created by The Learning Federation. This review surveyed 500 K-12 teachers from around Australia about their experiences of using learning objects. The review also involved conducting case studies in 6 different schools. A key result from this process was that "…teachers need considerable time to ensure that their selection of learning objects, from an increasingly wide range, is appropriate to their needs" (2005, p. 17). This result agrees with the findings from this study and it is suggested that future research is needed to investigate ways to decrease the amount of time taken to create an engaging learning experience that incorporates learning objects.

Issue 3: Resource Collection

The issue of resource collection specifically related to problems the participants faced while searching for and identifying appropriate learning objects. The issue was highly prevalent across all three data analysis stages of the research, ranking this issue as one of the more important issues the teachers faced.

Literature reviewed at the start of the project suggested that the uptake of learning objects (resources) was still in its infancy (Hand et al., 2004; L. Johnson, 2003; McCormick et al., 2004). The findings from this research support this with the participants involved in this project failing to incorporate any learning objects from the provided repositories i.e., Merlot and EdNA and in the latter stages of the study, the National Science Digital Library, Apple Interchange and The Learning Federation as well. This is despite the fact that the participants were provided with detailed instructions and training on how to use the repository sites, and the fact that the participants were being actively directed towards these repositories via the EPSS. The reasons behind this lack of use varied, however the most prevalent explanation indicated by the participants was that they preferred the use of the mainstream search engine Google™, largely because of its simple, user friendly interface, its ease of use and the success that the participants had had in finding other resources in their previous experiences. The main problem associated with this is the multimedia nature of many learning objects makes most of them unlocatable to text-based search engines like Google™ therefore resulting in a large number of learning objects suitable for educational use not being listed by the mainstream search engines. A consequence of this is that quality, often peer reviewed, learning objects are not being located or used. A recent iterative usability study (Najjar et al., 2005) which examined the use of search tools to find learning objects had similar findings. The researchers concluded that most people were lost in the complex structure of the search engines provided by learning object repositories. Furthermore, they even suggested that the use of simple keyword queries, like those used in Google™, should be used to locate learning objects in the future. This suggestion, when combined with the outcomes of this study, points towards the need for the search engines of learning object repositories to adopt a more simplistic approach with a basic interface that allows educational practitioners with limited technological expertise to explore a wider range of learning objects for classroom use.

On an encouraging note, during the course of this research several other studies have suggested that the application of learning objects by teachers is slowly increasing (Freebody et al., 2007; McCormick & Li, 2006; Schibeci et al., 2008) and that teachers' attitudes towards learning objects are also becoming more positive (McCormick & Li, 2006; Schibeci et al., 2008). This trend, when combined with the commitment by Australian State and Territory Governments to continually fund the production of high quality learning objects (MCEETYA, 2005) will not only see more learning objects made available but also more teachers willing to use them.

This positive trend points towards the need for future research in this area and it is recommended that another iteration of the development research process underlying this study be conducted using the design principles generated by this research. By undertaking this additional research a greater uptake of learning objects by the participants may occur.

Issue 4: Pedagogical Issues

The final issue to emerge from the data was associated with the pedagogical aspects of the participants' WebQuest. This issue related to the low scores the pedagogical sections of the WebQuests achieved, as judged by the evaluators. This is despite the participants averaging more than 15 years experience in creating teaching and learning activities in the K-12 environment. Further analysis of the data revealed that this issue was inversely related to the amount of time the participants spent working on the visual and technical characteristics of the WebQuest i.e., the more time teachers spend on the visual and technical aspects of their WebQuests, the less they spend on the pedagogical aspects. These findings are similar to a recent Australian study involving 20 pre-service teachers who had just completed an undergraduate course linking web authoring and education. The researchers reported that pre-service teachers "… may become overly focused on the technology…" (Chan & Lee, 2007, p. 93) when designing web-based learning activities.

To address this issue the prototype EPSS used two main approaches. The first approach involved the prototype directing the participants towards the pedagogical aspects of the learning design before the visual aspects. The web-based EPSS simulated this procedure by only allowing the participants access to the visual aspects of the design process once the pedagogical attributes were completed. The second approach used to address this issue involved integrating a variety of learning design taxonomies into the support system. These taxonomies not only provided technological assistance to the participants but also pedagogical guidance though instructionally sound, easily modifiable WebQuest templates. The purpose of this approach was to share the cognitive load of the participant by providing support for the lower level cognitive skills (i.e., developing technical and visual characteristics). The approach was designed to enable participants to concentrate more on the higher order thinking skills involved in synthesising the pedagogical aspects of their WebQuests i.e., constructing the task, process and evaluation. Despite these approaches, pedagogical issues still remained a concern after the final stage of the research, suggesting that even more pedagogical support is needed for K-12 teachers as they combine learning objects with learning designs. It is recommended that future research be conducted to investigate how K-12 teachers develop the pedagogical aspects of various learning designs when creating learning experiences.

In summary, the participants involved in this project faced four main issues as they attempted to combine learning objects with learning designs. These four issues: *Technological Competency, Time Limitations, Resource Collection*, and *Pedagogical Issues* relate specifically to two of the three research questions, with the remaining research question focusing directly on the scientific output of the study which according to Herrington, McKenny, Reeves and Oliver (2007) are the design principles generated by the research.

Design Principles Generated by the Research

The final 11 design principles generated by this research, where possible, have their foundations in peer reviewed literature and are based on current practice. All 11 design principles have been methodically and specifically created to inform the development and implementation decisions that instructional designers face when they are building systems to support teachers as they integrate the pedagogical use of learning objects with learning designs. These final design principles are shown in Table 5-2.

According to Herrington, McKenny, Reeves and Oliver (2007) design principles like these and the heuristic statements that support them (see the Chapter 4) are the scientific output of any development research project. Herrington et al. (2007) claim this as they believe design principles created by this type of research approach contain substantive and procedural knowledge that can be relevant to future researchers.

Table 5-2 The design principles generated by this research

Design Principle	
1	A system should be capable of completely generating the specific pages of a learning design.
2	A system should enable teachers to add an appropriate thematic style and graphics to the learning design.
3	A system must make best use of teachers' time.
4	A system must support teachers as they search for and locate appropriate learning objects.
5	A system must direct teachers to the pedagogical aspects of the design process before the visual aspects of the design.
6	The use of a supporting website can aid teachers as they combine learning objects with learning designs.
7	A system should be linear in design.
8	A system should actively engage the learner by developing and maintaining a shared goal.
9	A system should provide detailed steps with tailored assistance through cueing, prompting, questioning, modelling, telling and/or discussing.
10	A system should provide a deep approach to learning
11	A system should incorporate learning design templates.

While these 11 design principles are specific for the context in which they were developed in i.e., supporting K-12 teachers as they combine learning objects with learning designs, the actually functionality of the principles may be far wider reaching. Design principle 1 for example: *A system should be capable of completely generating the specific pages of a learning design,* could easily be followed when developing any support systems for learning designs at any level of education e.g., a system which supports lecturers as they develop learning designs at a tertiary level. Design principle 2: *A system should enable teachers to add an appropriate thematic style and graphics to the learning design* could be translated to the development of a support system which enables any teachers to build web pages e.g., a system should enable teachers to add a appropriate thematic style and graphics to the web page. To substantiate claims like these, a thorough investigation of the functionality of the 11 design principles needs to be conducted and it is a key recommendation of the research that the design principles are tested in a wide range of settings and applications. It is only after this has been completed that the true potential of the design principles will be realised.

Discussion about the Research Approach

Reeves' (2000) development research model was discussed in Chapter 3 as an approach to meet the needs of the study. During the time taken to conduct this research this approach has evolved and the research model has changed. While this does not affect the results, the evolution of the development research approach behind the study needs to be further discussed as it may influence future projects.

At the start of this research there was no agreement among researchers concerning a common term for development research, however a number of researchers used the terms "design research" (Reeves, Herrington, & Oliver, 2005) and "developmental research" (McKenney & Van den Akker, 2005). Over the last four years, one all encompassing term has been slowly gaining momentum in this area and it is '*design-based research*' that Reeves (2006) has elected to call his second version of the original development research process used in this study. An overview of this evolution can be seen in Figure 5-1.

Please see print copy for Figure 5.1

Figure 5-1 The evolution of development research into design-based research

Figure 5-1 shows the similarities in the design and layout of the two models, as well as the small but significant changes in the descriptions of each step, particularly the second and third steps. The second step in Reeves' 2006 design-based research model includes the introduction of existing design principles. These mirror the guidelines extracted from the literature and used towards the end of Stage 1 of this study. The other major change in Reeves' current model is the addition of iterative cycles introduced in the third step. This change is also mirrored in the design, development, expert review and modifications seen in Stage 4 of this study. Thus the changes Reeves made to his model accurately reflect the necessary steps involved in this real-world study. Therefore this study supports the modifications of Reeves' design-based research model.

Further Research

The continued interest in learning objects in educational institutions has seen a rapid growth in the research and the associated literature relating to their use (Schibeci et al., 2008). However, in the K-12 setting, development has been slow due in part to many of the issues revealed in this study. To help overcome these issues this study has highlighted the need for further research in the following areas:

- Further iterations of the development research process, using the design principles generated in this study, to develop electronic performance support systems to aid teachers as they try to combine learning objects with learning designs.
- Investigating the quality and effectiveness of the teaching and learning experiences created by teachers who utilise a support system developed according to design principles generated in this study.
- Identification of additional strategies to decrease the amount of time taken to create engaging learning experiences which incorporate learning objects.
- Investigating the ability and benefits that a simple, user friendly learning object repository search engine may have in assisting K-12 teachers as they locate and identify appropriate learning objects.
- Investigating how K-12 teachers can best utilise the pedagogical scaffolding provided by various learning designs, other than WebQuests, to creating teaching and learning experiences which incorporate learning objects.
- Investigating how support systems, similar to the web-based EPSS developed in this study, can assist K-12 teachers as they incorporate learning objects into a variety of other learning designs.
- An investigation of the effectiveness of K-12 teachers working collaboratively to create learning designs that incorporate learning objects.

These areas recommended for future research have directly stemmed from this study. It is through further work in these areas that additional indications of the use and effectiveness of integrating learning objects with learning designs will be realised.

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APPENDIX A

ADVERTISEMENT OF WORKSHOPS

Would you like to be able to make better use of the Internet in your teaching?

Do you wish you had time to create a Webpage or Web Quest to use with your class?

If you answered yes, then attend either of the following workshops to create your own webpage or Web Quest using Dreamweaver. As part of a research project, the University of Wollongong is offering you the opportunity to build on the skills you already have to be able to efficiently create webpages using available resources from the Internet.

Time: 4pm – 6pm

Place: Digital Multimedia Lab (DMC) Room 22.107
Located upstairs in Building 22 opposite the Curriculum Resource Centre (CRC)

Cost: Free (Tea and Coffee Provided)

Dates: Attend in either Term 2 or Term 3 – Each course comprises of four workshops with the focus being either webpage or Web Quest. Participants need to attend all four workshops in the course. There is a limit of 20 participants in each course.

	Term 2 Webpage focus	Term 2 Web Quest focus	Term 3 Webpage focus	Term 3 Web Quest focus
Week 1	10th May	11th May	2nd August	3rd August
Week 2	17th May	18th May	9th August	10th August
Week 3	24th May	25th May	16th August	17th August
Week 4	31st May	1st June	23rd August	24th August

What we provide:

- Technical Support
- A place to put your webpage or Web Quest online and support to link it with your schools webpage.

What you will get out of the course:

- Enhanced Web creation skills using Dreamweaver.
- A completed webpage or Web Quest on a topic you have chosen – related to the units of work you are doing at school.

For more information or to enrol email Chris Campbell
chrissie@uow.edu.au or complete the section below and return to:
Chris Campbell Faculty of Education University of Wollongong NSW 2522

Name: ____________________ School: ____________________

Contact Number: ____________________ Contact Email: ____________________

I am registering for the: ❑ Term 2 ❑ Term 3

❑ Webpage Workshop ❑ Web Quest workshop

Have you created a webpage before? ❑ Yes ❑ No

Have you used Dreamweaver before? ❑ Yes ❑ No

APPENDIX B

WORKSHOP DESCRIPTIONS

Outline of Workshop Series One

Session (Length)	Time	Content
1 (2 hours)	10 mins	Course Introduction ▪ General Information Questionnaire
	20 mins	Introduction to WebQuests: ▪ What are WebQuests? ▪ The parts of a WebQuest ▪ Examples of WebQuests
	30 mins	Introduction to Learning Objects ▪ Where do the participants currently get their digital resources from? ▪ Examples of Repositories and Learning Objects
	25 mins	Introduction to Dreamweaver™ ▪ The basic features – changing font, inserting pictures and hyperlinks. ▪ Tables
	35 mins	Time for planning the learning design.
2 (2 hours)	30 mins	Dreamweaver instructions ▪ Revision of last week ▪ Changing back grounds
	30 mins	The visual aspects of learning designs ▪ The use of colours, layout, using text ▪ Examples
	60 mins	Time for development of learning designs
3 (2 hours)	120 mins	Time for development of learning designs
4 (2 hours)	120 mins	Time for development of learning designs

Outline of Workshop Series Two

Session (Length)	Time	Content
1 (2 hours)	10 mins	Course Introduction · General Information Questionnaire
	20 mins	Introduction to WebQuests: · What are WebQuests? · The parts of a WebQuest · Examples of WebQuests
	30 mins	Introduction to Learning Objects · Where do the participants currently get their digital resources from? · Examples of Repositories and Learning Objects
	25 mins	Introduction to the prototype EPSS · The flowchart · The templates · The supporting website
	35 mins	Time for planning the learning design.
2 (2 hours)	30 mins	Introduction to Dreamweaver™
	30 mins	The visual aspects of learning designs · The use of colours, layout, using text · Examples
	60 mins	Time for development of learning designs using the prototype EPSS
3 (2 hours)	120 mins	Time for development of learning designs using the prototype EPSS
4 (2 hours)	120 mins	Time for development of learning designs using the prototype EPSS

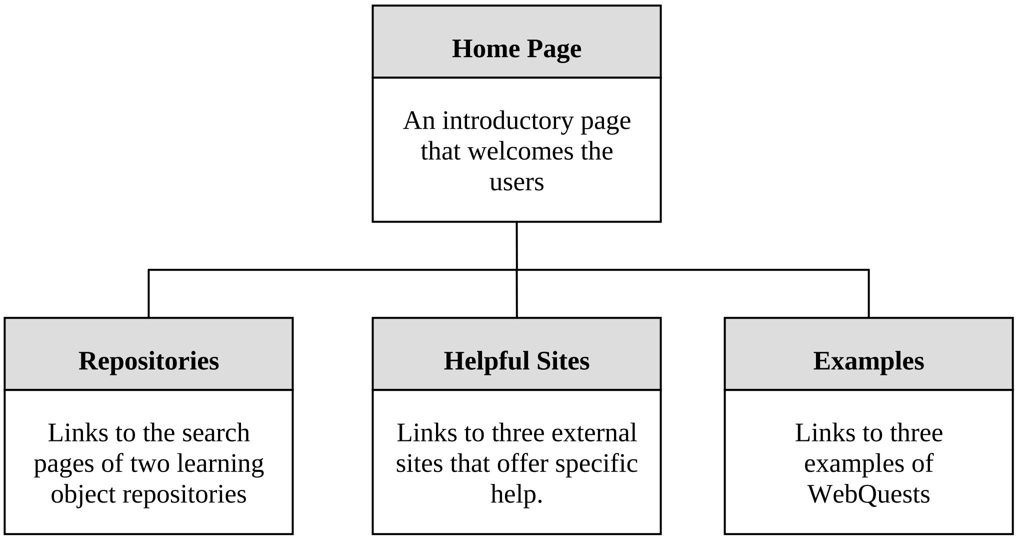
Outline of Workshop Series Three

Session (Length)	Time	Content
1 (2 hours)	10 mins	Course Introduction ▪ General Information Questionnaire
	15 mins	Introduction to the web-based EPSS
	20 mins	Introduction to WebQuests: ▪ What are WebQuests? ▪ The parts of a WebQuest ▪ Examples of WebQuests
	30 mins	Introduction to learning objects ▪ Where do the participants currently get their digital resources from? ▪ Examples of Repositories and Learning Objects
	45 mins	Time for planning the learning design.
2 (2 hours)	120 mins	Time for development of learning designs using the prototype EPSS
3 (2 hours)	30 mins	Introduction to Dreamweaver™
	90 mins	Time for development of learning designs using the prototype EPSS
4 (2 hours)	120 mins	Time for development of learning designs using the prototype EPSS

APPENDIX C

SUPPORTING WEB SITE FOR WORKSHOP SERIES 1

A map of the supporting web used in the first series of workshops



APPENDIX D

GENERAL INFORMATION QUESTIONNAIRE

General Information Questionnaire

Dear Participant,

Please take the time to fill out the following questionnaire. This questionnaire will be used to compile a profile of our subject group. Your personal details will not be recorded with or on this questionnaire before or during analysis.

Name: ____________________

1. Please indicate your gender:

   ☐ Male ☐ Female

2. Date of birth: ____________

3. How many years have you been teaching? ____________

4. What is your area of expertise?

   ☐ Primary ☐ English
   ☐ Maths ☐ Science
   ☐ TAS ☐ Creative Arts
   ☐ PDHPE ☐ LOTE
   ☐ HSIE ☐ Careers

5. What Stage(s) do you teach:

   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6

6. Please indicate your level of comfort with using computer:

   ☐ Very comfortable ☐ Comfortable
   ☐ Slightly uncomfortable ☐ Uncomfortable

7. Please indicate your level of experience in developing web pages:

   ☐ Advanced ☐ Intermediate
   ☐ Beginner ☐ Never used computer before

8. If you have developed web pages before, what programs did you used?

   ☐ Dream weaver ☐ Microsoft FrontPage
   ☐ Claris Homepage ☐ HTML code
   ☐ Other (please list) ____________________

9. How do you use computers in your teaching?

   a. I incorporate the use of networked communication (email, video conferencing) into instructional activities. ☐ Yes ☐ No

   b. I use teacher productivity, assessment, and instructional management tools to monitor and organise information. ☐ Yes ☐ No

   c. I encourage my students to use applications to create and/or manipulate data to complete assignment/projects ☐ Yes ☐ No

10. Do you use electronic resources (CD-ROMs, the internet) in your teaching?

    ☐ Yes ☐ No

    If you answered yes, how you do use electronic resources in your teaching?

    ____
    ____
    ____
    ____
    ____

11. What do you hope to achieve with this workshop?

    ____
    ____
    ____
    ____

*** Thank you for your time ***

University of Wollongong

APPENDIX E

WEBQUESTS AND RESOURCES SHEET

WebQuests and Resources

Name: ______________________________

What resources are you using in your WebQuest?

How did you find these resources?

What made you select these resources?

Did you consider using any other resources? Why did you choose not to?

APPENDIX F

INTERVIEW GUIDE

Phone Interview Questions

Thanks for agreeing to this follow up interview about your participation in the WebQuests and Learning objects workshop. The main focus from my point of view is to look at the issues faced as you created your WebQuest using learning objects.

So the plan for the next 10 minutes is to run through some questions. Please feel free to raise anything else that you would like to talk about along the way. So that I can concentrate on what you are saying rather than taking notes, would you mind if I recorded our conversation?

Section 1 – WebQuests and Learning Objects

My first set of questions is about the first session where we introduced the concepts of WebQuests and Learning Objects.

1. Have you heard about WebQuests before?
    a. Where, how, what context, have you used them?
2. Have you heard about learning objects before?
    a. Where, how, what context, have you used them?
3. What was your initial reaction to the website?
    a. Colour, motivating, inviting?
4. What did you think of the explanation at the start?
    a. Were the examples useful?

Section 2 – Combining Learning Objects with WebQuests

The next series of questions are to do with using the Learning Objects with your WebQuest.

1. What type of learning objects did you use?
2. How did you find these Learning objects?
3. What made you select these Learning Objects?
4. Did you consider any others?
5. How easy were they to find?
6. Do you think the website help you find these Learning Objects?
7. What problems did you have when you first starting try to use these resources with your WebQuest?

Section 3 – Using Dreamweaver™

Finally the last section deals with using Dreamweaver

1. Have you developed many web pages before?
2. So how on a scale of 1 to 10 how would you rate your Dreamweaver skills before the work shop… and after?
3. What sort of things did you find difficult to do when you added graphics and colour to your WebQuest?

*** Stage 1 interviews stop here *** Thank you very much for your time ***

Section 4 – The Prototype EPSS or Web-Based EPSS

The next sets of questions are about the EPSS

1. Did you get a chance to look through the examples templates provided?
    a. What were your initial thoughts?
    b. Did they seem hard or easy?
2. What topic did you decide on?
    a. Why? How do you come up with it?
3. What were your initial thoughts when you first started entering information into the web site?
    a. *What problems did you encounter when you tried to entry data into the pop up text boxes? (WEB-BASED EPSS ONLY)*
4. What do you think about the sequence of the steps involved in designing a WebQuest?
    a. Was it confusing, did it appear logical, was the information provided useful? Did you follow the sequence provided?
5. Did it provide information when you needed it
6. Do you think it reduced the time required to develop a WebQuest
7. What other problems did your have with the EPSS?
8. What were your thoughts on the download process? *(WEB-BASED EPSS ONLY)*

Section 5 – General Summary

To sum up…

1. Overall, how would you rate the EPSS as a support tool for creating WebQuests?
2. What did you like most about it?
3. What did you like least about it?
4. If you had the opportunity to develop and design your own EPPS to help design WebQuests, how would you do it?

*** Thank you very much for your time ***

APPENDIX G

WEBQUEST EVALUATION RUBRIC

WebQuest Name: ________________________

	Beginning	Developing	Accomplished	Comments
Overall Aesthetics (This refers to the WebQuest itself, not the External Links)				
Overall Visual Appeal	*0 points*	*2 points*	*4 points*	
Navigation & Flow	*0 points*	*2 points*	*4 points*	
Mechanical Aspects	*0 points*	*1 point*	*2 points*	
Introduction				
Motivational Effectiveness of Introduction	*0 points*	*1 point*	*2 points*	
Cognitive Effectiveness of the Introduction	*0 points*	*1 point*	*2 points*	
Task (The task is the end result of students efforts … not the steps involved in getting there)				
Connection of Task to Standards	*0 points*	*2 point*	*4 points*	
Cognitive Level of the Task	*0 points*	*3 points*	*6 points*	
Process (The process is the step by step description of how students will accomplish the task.)				
Clarity of Process	*0 points*	*2 points*	*4 points*	
Scaffolding of Process	*0 points*	*3 points*	*6 points*	
Richness of Process	*0 points*	*1 points*	*2 points*	
Resources (Note: you should evaluate all resources linked to the page, even if they are in sections other than the Process block. Also note that books, video and other off-line resources can and should be used where appropriate.)				
Relevance & Quantity of Resources	*0 points*	*2 points*	*4 points*	
Quality of Resources	*0 points*	*2 points*	*4 points*	
Evaluation				
Clarity of Evaluation Criteria	*0 points*	*3 points*	*6 points*	

General Comments

Total: / 50

WebQuest Evaluation

	Beginning	Developing	Accomplished
Overall Aesthetics (This refers to the WebQuest itself, not the External Links)			
Overall Visual Appeal	*0 points* There are few or no graphic elements. No variation in layout or typography. OR Colour is garish and/or typographic variations are overused and legibility suffers. Background interferes with the readability.	*2 points* Graphic elements sometimes, but not always, contribute to the understanding of concepts, ideas and relationships. There is some variation in type size, color, and layout.	*4 points* Appropriate and thematic graphic elements are used to make visual connections that contribute to the understanding of concepts, ideas and relationships. Differences in type size and/or color are used well and consistently.
Navigation & Flow	*0 points* Getting through the lesson is confusing and unconventional. Pages can't be found easily and/or the way back isn't clear.	*2 points* There are a few places where the learner can get lost and not know where to go next	*4 points* Navigation is seamless. It is always clear to the learner what all the pieces are and how to get to them
Mechanical Aspects	*0 points* There are more than 5 broken links, misplaced or missing images, badly sized tables, misspellings and/or grammatical errors.	*1 point* There are some broken links, misplaced or missing images, badly sized tables, misspellings and/or grammatical error	*2 points* No mechanical problems noted
Introduction			
Motivational Effectiveness of Introduction	*0 points* The introduction is purely factual, with no appeal to relevance or social importance OR The scenario posed is transparently bogus and doesn't respect the media literacy of today's learners.	*1 point* The introduction relates somewhat to the learner's interests and/or describes a compelling question or problem.	*2 points* The introduction draws the reader into the lesson by relating to the learner's interests or goals and/or engagingly describing a compelling question or problem.
Cognitive Effectiveness of the Introduction	*0 points* The introduction doesn't prepare the reader for what is to come, or build on what the learner already knows.	*1 point* The introduction makes some reference to learner's prior knowledge and previews to some extent what the lesson is about.	*2 points* The introduction builds on learner's prior knowledge and effectively prepares the learner by foreshadowing what the lesson is about.
Task (The task is the end result of students efforts … not the steps involved in getting there)			
Connection of Task to Standards	*0 points* The task is not related to standards.	*2 point* The task is referenced to standards but is not clearly connected to what students must know and be able to do to achieve proficiency of those standards.	*4 points* The task is referenced to standards and is clearly connected to what students must know and be able to do to achieve proficiency of those standards.
Cognitive Level of the Task	*0 points* Task requires simply comprehending or retelling of information found on web pages and answering factual questions.	*3 points* Task is doable but is limited in its significance to students' lives. The task requires analysis of information and/or putting together information from several sources.	*6 points* Task is doable and engaging, and elicits thinking that goes beyond rote comprehension. The task requires synthesis of multiple sources of information, and/or taking a position, and/or going beyond the data given and making a generalization or creative product.

Process (The process is the step by step description of how students will accomplish the task.)			
Clarity of Process	*0 points* Process is not clearly stated. Students would not know exactly what they were supposed to do just from reading this.	*2 points* Some directions are given, but there is missing information. Students might be confused.	*4 points* Every step is clearly stated. Most students would know exactly where they are at each step of the process and know what to do next.
Scaffolding of Process	*0 points* The process lacks strategies and organizational tools needed for students to gain the knowledge needed to complete the task. Activities are of little significance to one another and/or to the accomplishment of the task.	*3 points* Strategies and organizational tools embedded in the process are insufficient to ensure that all students will gain the knowledge needed to complete the task. Some of the activities do not relate specifically to the accomplishment of the task.	*6 points* The process provides students coming in at different entry levels with strategies and organizational tools to access and gain the knowledge needed to complete the task. Activities are clearly related and designed to take the students from basic knowledge to higher level thinking. Checks for understanding are built in to assess whether students are getting it.
Richness of Process	*0 points* Few steps, no separate roles assigned.	*1 points* Some separate tasks or roles assigned. More complex activities required.	*2 points* Different roles are assigned to help students understand different perspectives and/or share responsibility in accomplishing the task.
Resources (Note: you should evaluate all resources linked to the page, even if they are in sections other than the Process block. Also note that books, video and other off-line resources can and should be used where appropriate.)			
Relevance & Quantity of Resources	*0 points* Resources provided are not sufficient for students to accomplish the task. OR There are too many resources for learners to look at in a reasonable time.	*2 points* There is some connection between the resources and the information needed for students to accomplish the task. Some resources don't add anything new.	*4 points* There is a clear and meaningful connection between all the resources and the information needed for students to accomplish the task. Every resource carries its weight.
Quality of Resources	*0 points* Links are mundane. They lead to information that could be found in a classroom encyclopaedia.	*2 points* Some links carry information not ordinarily found in a classroom.	*4 points* Links make excellent use of the Web's timeliness and colourfulness. Varied resources provide enough meaningful information for students to think deeply.
Evaluation			
Clarity of Evaluation Criteria	*0 points* Criteria for success are not described.	*3 points* Criteria for success are at least partially described.	*6 points* Criteria for success are clearly stated in the form of a rubric. Criteria include qualitative as well as quantitative descriptors. The evaluation instrument clearly measures what students must know and be able to do to accomplish the task.

APPENDIX H

HUMAN RESEARCH ETHICS PERMISSION

FINAL APPROVAL
In reply please quote: RN:ES HE03/379
Further Enquiries: Eve Steinke (PH: 42214457)

6 April 2004

Mr W Cotton
Faculty of Education
University of Wollongong

Dear Mr Cotton,

I am pleased to advise that the following Human Research Ethics application has been approved. As a condition of approval, the Human Research Ethics Committee requires that researchers immediately report anything which might warrant review of ethical approval of the protocol, including: serious or unexpected adverse effects on participants, proposed changes to the protocol, unforseen events that might affect continued ethical acceptability of the project and discontinuation of the research project before the expected date of completion.

Ethics Number:	HE03/379
Project Title:	The design of performance support systems to contextualise generic learning designs
Name of Researchers:	W.Cotton; Dr.L.Lockyer, Dr.G.Brickell
Final Approval Date:	5 April 2004
Date for Renewal:	4 April 2005

This certificate relates to the research protocol submitted in your original application and includes all approved amendments to date.

Please note that research projects of long duration must be reviewed annually by the Committee and it will be necessary for you to apply for renewal of this application if this project is to continue beyond one year.

Yours Sincerely,

L Palagolo

Assoc. Prof. Rod Nillsen
Chairperson, Human Research Ethics Committee
cc

University of Wollongong

INITIAL APPLICATION APPROVAL
In reply please quote: HE05/294
Further Enquiries Phone: 4221 4457

24 November 2005

Mr Wayne Cotton
Faculty of Education
University of Wollongong

Dear Mr Cotton

I am pleased to advise that the Human Research Ethics application referred to below has been **approved**.

Ethics Number:	HE05/294
Project Title:	The reliability of a WebQuest evaluation
Name of Researchers:	Mr Wayne Cotton, Dr Lori Lockyer
Approval Date:	24 November 2005
Expiry Date:	23 November 2006

This certificate relates to the research protocol submitted in your original application of **08/11/05**. As a condition of approval, the Human Research Ethics Committee requires that researchers immediately report:

- proposed changes to the protocol including changes to investigators involved
- serious or unexpected adverse effects on participants
- unforseen events that might affect continued ethical acceptability of the project.

You are also required to complete monitoring reports annually and at the end of your project. These reports are sent out approximately 6 weeks prior to the date your ethics approval expires. The reports must be completed, signed by the appropriate Head of School, and returned to the Research Services Office prior to the expiry date.

Yours Sincerely,

Dr Garry Hoban
Chairperson
Human Research Ethics Committee

cc: Dr Lori Lockyer, Gwyn Brickell, Education

APPENDIX I

Content Validity Expert Review Panel

The following panel of three experts examined the WebQuest Evaluation Rubric for content validity.

Dr. Jan Herrington
Associate Professor in Information Technology
Faculty of Education, University of Wollongong

Dr. Douglas Reid
Lecturer in Information Technology
Faculty of Education, University of Wollongong

Dr. Christine Campbell
Lecturer in Information Technology
Faculty of Education, Latrobe University

APPENDIX J

WEB-BASED EPSS EXPERT REVIEW PANEL MEMBERS

The following panel of five experts reviewed the web-based EPSS

Mr. Robert Wright
Education Media Lab Project Director
Faculty of Education, University of Wollongong

Dr. Jan Herrington
Associate Professor in Information Technology
Faculty of Education, University of Wollongong

Dr. Sue Bennett
Senior Lecturer in Information Technology
Faculty of Education, University of Wollongong

Mr. Martin Olmos
Project Manager
Faculty of Education, University of Wollongong

Dr. Christine Campbell
Lecturer in Information Technology
Faculty of Education, Latrobe University

APPENDIX K

EPSS Expert Review Tool

Faculty of Education
University of Wollongong
Wollongong, NSW 2522
Australia
Tel: (+61 2) 4221 3312
Fax: (+61 2) 4221 4321
wcotton@uow.edu.au
www.uow.edu.au

Expert Review – Piecing Together WebQuest Web Site

Dear Reviewer

I would like to thank you for agreeing to review the Web site constructed for the Innovative Technology Schools Conference. Your feedback will be a great help in reviewing and revising the Web site before it is implemented. Here's a bit of background information about my research and the prototype Web site to give you some context:

My Research
The project is being conducted as part of a Doctor of Philosophy supervised by Dr. Lori Lockyer and Dr. Gwyn Brickell. The main aim of the investigation is to develop a simple support system that assists K-12 teachers as they combine learning designs with digital learning objects. I am using WebQuests as a suitable learning design, mainly because they incorporate "resources" (learning objects, electronic resources, educational Web sites) in there design.

The Web Site & Review
The purpose of the Web site is two fold. Firstly it aims to briefly introduce K-12 teachers to the topics of WebQuests and Learning Objects. It also aims to provide support to these teachers as they design their own WebQuest using learning objects.

The Web site can be accessed at the following address:

http://brink2.uow.edu.au/~webquest/

Please explore the site, read the information provided, follow the external links and have a go at designing your own WebQuest. I'm interested in your impression on all aspects of the site.

On the attached form, I have listed a number of questions that I would like you to consider when reviewing the site. If you run into any difficulty while reviewing the site, have any questions, or would like to discuss the review, please do not hesitate to contact me:

Mobile:	04 3940 8036
University Ph:	02 4221 3312
Email:	wcotton@uow.edu.au

As the Web site must be revised based on feedback provided by you and other experts, I would appreciate it if you could finish your review by Monday, 27th November. I will come around and collect your comments.

Thanks again for your help; I am looking forward to your comments

Sincerely,

Wayne Cotton

Piecing Together WebQuests

Part 1 - Reviewer Details

Name: ______________________________

Phone: ______________________________

Position: ______________________________

Organisation: ______________________________

Please provide a brief description of your experience in IT

Computer type used to access the Web: Mac □ PC □ Other _______

Web Browser used to view Site: □ Internet Explorer – version ____

□ Safari – Version _____________

□ Other: ____________________

Part 2 - Site Structure and Navigation

Were you able to move to all areas of the site without difficulty? Yes □ No □

Did you encounter any specific problems when navigating around the site?

Was the site aesthetically attractive? Yes □ No □

Are their specific aspects about the site that you found appealing/unappealing?

Part 3 - Quality and Depth of Content

Was the information clear and easy to read? Yes ☐ No ☐

If not, please note the areas you found unclear and what was problematic about the information	

Are the links to external Websites appropriate? Yes ☐ No ☐

Please list any inappropriate links, and /or any other external sites that you think could be included	

Part 4 – Describing WebQuests and Learning Objects

Are the links to external Websites appropriate? Yes ☐ No ☐

Please list any inappropriate links, and /or any other external sites that you think could be included	

Part 5 – General Comments

I would appreciate any other comments or suggestions you may have regarding the Web site.

Part 6 – The Steps in Piecing Together WebQuests

Please provide your comments on each of the sections in this Web site

Steps	Is the step clearly described? If not, how could it be improved	Does the step provide enough support? If not, what else is needed
Step 1 – Selecting a WebQuest		
Step 2 – The Title Page		
Step 3 – Task, Process & Resources		
Step 4 – The Evaluation		
Step 5 – The Final Pieces		
Step 6 – Saving your Files		

Thank you for taking time to provide feedback on the Web site.

APPENDIX L

INFORMATION SHEETS AND CONSENT FORMS

Faculty of Education
University of Wollongong
Wollongong, NSW 2522
Australia
Tel: (+61 2) 4221 3312
Fax: (+61 2) 4221 4321
wcotton@uow.edu.au
www.uow.edu.au

Participant Information Sheet – Web Workshop

Dear Student

We would like to invite you to participate in this study which focuses on the development of a Performance Support System (PSS). The project is being conducted as part of a Doctor of Philosophy supervised by Dr. Lori Lockyer and Dr. Gwyn Brickell. The main aim of the investigation is to develop a system that assists teachers and designers as they combine learning designs with digital learning objects.

The final phase of the project funded by the University aims to develop a greater understanding of the perceived issues teachers face as they attempt to use learning designs with learning objects.

We are seeking advice from students who are interested in working with this latest technology.

Your involvement will include:

- Attending two 20-minute sessions at the university, which will primarily cover the process of evaluating a WebQuest.

Your participation in this study is entirely voluntary and you may withdraw at any time by contacting one of the researchers named below. Refusal to participate in the study will, in no way, affect your relationship with the University of Wollongong. Should you withdraw from the study; all data collected about you will be destroyed.

Any questions about the study can be directed to any of the researchers. Concerns or complaints regarding the way in which the research is or has been conducted should be directed to the Secretary of the University of Wollongong Human Research Ethics Committee on (02) 4221 4457.

Researchers:
Wayne Cotton and Drs Lori Lockyer and Gwyn Brickell
Faculty of Education
University of Wollongong
Wollongong NSW 2522
Phone (02) 4221 3312
Email wgc01@uow.edu.au

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Australia
Tel: (+61 2) 4221 3312
Fax: (+61 2) 4221 4321
wcotton@uow.edu.au
www.uow.edu.au

Participant Consent Form – Web Workshop

I have been given information about the Investigating the factors that influence the use of electronic learning resources in the K-12 educational context project and have discussed it with the researchers.

I understand that, if I consent to participate in this project I will be asked to participate in:

- Two 20-minute sessions at the university which will primarily cover the process of evaluating a WebQuest.

I have been advised of the potential risks and burdens associated with this research, which include the time to participate in the workshops. I have had the opportunity to ask the researchers any questions I have about the research and my participation.

I understand that my participation is voluntary. I am free to refuse to participate and I am free to withdraw at any time. My refusal to participate or withdraw consent will not affect my relationship with the University of Wollongong.

If I have enquiries about the research I can contact the researchers according to the details provided on the information sheet. If I have concerns or complaints about the way in which the research is or has been conducted I can call the Secretary of the University of Wollongong Human Research Ethics Committee on (02) 4221 4457.

By signing below I am indicating my consent to participate in the project as it has been described to me in the information sheet and through discussion with the researchers. I understand the data collected from my participation will be analysed and reported anonymously in conference and journal publications and I consent for it to be used in this manner.

Signed   Date

…………………………………………………….   …………/……………/……………….

Name (please print)

…………………………………………………….

Researchers:
Wayne Cotton, Drs Lori Lockyer, and Gwyn Brickell
Faculty of Education
University of Wollongong
Wollongong NSW 2522
Phone (02) 4221 3312
Email wgc01@uow.edu.au

APPENDIX M

RESEARCHER EVALUATIONS OF PARTICIPANT WEBQUESTS FROM STAGE 1

Participant	Description	Criteria		Rating	Comments on Application of Criteria
1	Title: Eat your way to Health Focus: Age 14 - 15 Description: A WebQuest where year 9 students are required to make an informative brochure about a disease. Level of Completion: 5/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	4 4 1 **9**	Eat your way to Health was visually appealing and structured out in a logical fashion, although some hyperlinks were not working.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	1 1 **2**	The introduction was short and clear, but more information was needed.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	0 3 **3**	The simple task was not connected to teaching standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	4 3 0 **7**	A clearly explained process was given, but it lacked the depth needed to solve the task.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	2 2 **4**	One broken hyperlink to an informative government website was given.
		Evaluation	Clarity of Evaluation /6	**0**	This section was started but not finished.
		TOTAL	**(% of Attributes Commenced)**	**50**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
2	Title: The Noisy Insects Focus: Ages 7- 8 Description: In this WebQuest students in years 3 and 4 are invited to investigate an insect shell found in the school grounds. Level of Completion: 5/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	2 2 1 **5**	On the surface this WebQuest looked good, but it contained broken hyperlinks and flow through the WebQuest was hindered.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	2 2 **4**	An engaging introduction that draws on the learner's prior knowledge.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	0 3 **3**	A doable task was given, but it lacked significance and no connection to standards was given.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	4 3 0 **7**	A clearly stated process, however more complex activities with more steps would have added to the process.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	2 2 **4**	Only some connection between the basic resources and the task.
		Evaluation	Clarity of Evaluation /6	**0**	This section was started but not finished.
		TOTAL	**(% of Attributes Commenced)**	**46**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
4	Title: The Greenhouse Effect Focus: Not Given Description: A partial completed WebQuest on the Greenhouse Effect in which the task is the only working attribute. Level of Completion: 2/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	0 0 0 **0**	This WebQuest was started and a few pages had structure, but there was no meaningful content or any working hyperlinks.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	n/c n/c **n/c**	Section was included but not commenced.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	0 3 **3**	A doable task was given, but it lacked significance.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	n/c n/c n/c **n/c**	Section was included but not commenced.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	n/c n/c **n/c**	Section was included but not commenced.
		Evaluation	Clarity of Evaluation /6	**n/c**	Section was included but not commenced.
		TOTAL	**(% of Attributes Commenced)**	**15**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
7	Title: Frogs Focus: Not Given Description: A WebQuest where students have to complete a number of questions sheets on frogs. Level of Completion: 5/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	2 2 1 **5**	On the surface this WebQuest looked good, but it contained broken hyperlinks and flow through the WebQuest was hindered.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	2 2 **4**	An engaging introduction that draws on the learner's prior knowledge.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	2 3 **5**	A doable task was given, but it lacked significance and was only partially connected to the standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	2 3 1 **6**	Some confusing instructions were given, but more detail was needed for the learners to complete the task.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	4 2 **6**	This WebQuest linked to a number of web sites on frogs, but the quality of these sites was questionable.
		Evaluation	Clarity of Evaluation /6	**0**	This section was started but not finished
		TOTAL	**(% of Attributes Commenced)**	**52**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
9	Title: Wet and Dry Environments Focus: Ages 7 - 8 Description: A WebQuest aimed at students in years 3 and 4 that focuses on a self selected environmental task. Level of Completion: 5/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	4 2 2 **8**	A visually appealing WebQuest with no mechanical problems, however it was easy to get lost within the WebQuest.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	2 2 **4**	An engaging introduction that draws on the learner's prior knowledge.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	2 3 **5**	A doable task was given, but it lacked significance and was only partially connected to the standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	2 3 1 **6**	More directions and steps were needed to actively solve the task.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	0 0 **0**	No learning objects or other resources were given.
		Evaluation	Clarity of Evaluation /6	**3**	The criteria for success were partially given.
		TOTAL	**(% of Attributes Commenced)**	**54**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
12	Title: The History of Dapto Focus: Ages 7 - 8 Description: This WebQuest requires year 3 and 4 students to create a PowerPoint presentation about the local history. Level of Completion: 5/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	4 2 1 **7**	A visual appealing WebQuest, that contained a number of broken hyperlink causing issues with the HTML frames.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	2 2 **4**	An engaging introduction that draws on the learners prior knowledge.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	0 6 **6**	A task that promotes a deeper approach to learning was given, but it was not connected to standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	4 3 1 **8**	The steps that were given were clearly stated, but more steps were required to actively engage the learner.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	2 2 **4**	There was only some connection between the hyperlinked web pages and the task.
		Evaluation	Clarity of Evaluation /6	**3**	The criteria for success were partially given.
		TOTAL	**(% of Attributes Commenced)**	**64**	

APPENDIX N

RESEARCHER EVALUATIONS OF PARTICIPANT WEBQUESTS FROM STAGE 3

Participant	Description	Criteria		Rating	Comments on Application of Criteria
15	Title: DinoQuest Focus: Not Given Description: In this WebQuest students are given the ‘dangerous’ task of searching the WWW to find facts on dinosaurs, then they can create and name their own dinosaur. Level of Completion: 5/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	4 4 1 **9**	A visual appealing WebQuest that was easy to navigate, despite two broken external hyperlinks.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	1 1 **2**	There were a few places were a learner could get lost and some broken links.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	2 3 **5**	The doable task was not engaging, nor was it clearly connected to standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	4 2 1 **7**	The processes were clearly stated, but they lacked the strategies needed to complete the task and more complex activities were needed.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	2 2 **4**	Only some connection between the basic resources and the task.
		Evaluation	Clarity of Evaluation /6	0	The criteria for success were not given.
		TOTAL	**(% of Attributes Commenced)**	**54**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
16	Title: Frankie's One Stop Organ Shop Focus: Ages 14 – 15 Description: This WebQuest requires students to research a body organ and then design a poster for 'Dr. Frankenstein' which sells the body organ. Level of Completion: 5/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	2 4 2 **8**	No mechanical problems were found, but the WebQuest is very bright and this is detrimental to the task.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	2 2 **4**	The introduction was engaging and effective.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	2 6 **8**	The doable and engaging task was not clearly connected to standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	4 3 1 **8**	Every step was clearly stated; however more complex activities which cater for a higher level of thinking were needed.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	2 4 **6**	The resources given provided meaningful information however more resources were needed.
		Evaluation	Clarity of Evaluation /6	0	The criteria for success were not given.
		TOTAL	**(% of Attributes Commenced)**	**68**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
17	Title: Life Cycles Focus: Ages 14 – 15 Description: During this WebQuest students are required to imagine that they are sent on a mission to earth to investigate living objects and compare their life cycles. Level of Completion: 5/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	4 4 1 **9**	This was a visually appealing WebQuest; however it contained a few broken links.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	2 1 **3**	The introduction was engaging, however it lacked direction.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	0 3 **3**	The Task was doable, but it lacked significance and was not connected to standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	2 6 2 **10**	The process allowed for different ability levels and for students to collaborate, but bit of the steps were confusing.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	4 4 **8**	There was a clear and meaningful connection to the task and the resources encouraged a deeper approach to learning.
		Evaluation	Clarity of Evaluation /6	**3**	The criteria for success were partially given.
		TOTAL	**(% of Attributes Commenced)**	**72**	

<table>
<tr><th>Participant</th><th>Description</th><th colspan="2">Criteria</th><th>Rating</th><th>Comments on Application of Criteria</th></tr>
<tr><td rowspan="7">19</td><td rowspan="7">Title: Under the Sea

Focus: Not Given

Description: Students are required to don a detective hat in this WebQuest and investigate various sea animals and find out about their habitats, what they eat and look like.

Level of Completion: 5/5 attributes commenced.</td><td>Overall Aesthetics</td><td>Visual Appeal /4
Navigation /4
Mechanical Aspects /2
Sub-Total /10</td><td>4
2
2
8</td><td>This was a visually appealing WebQuest; however the external hyperlinks were confusing.</td></tr>
<tr><td>Introduction</td><td>Motivational Effectiveness /2
Cognitive Effectiveness /2
Sub-Total /4</td><td>2
2
4</td><td>The introduction was engaging and effective.</td></tr>
<tr><td>Task</td><td>Connection of Tasks to Standards /4
Cognitive Level of Tasks /6
Sub-Total /10</td><td>2
6
6</td><td>The doable and engaging task was not clearly connected to standards.</td></tr>
<tr><td>Process</td><td>Clarity of Process /4
Scaffolding of Process /6
Richness of Process /2
Sub-Total /12</td><td>4
3
2
9</td><td>The processes were clearly stated, but they lacked the strategies needed to complete the task.</td></tr>
<tr><td>Resources</td><td>Relevance & Quantity of Resources /4
Quality or Resources /4
Sub-Total /8</td><td>2
2
4</td><td>Only some connection between the basic resources and the task.</td></tr>
<tr><td>Evaluation</td><td>Clarity of Evaluation /6</td><td>0</td><td>The criteria for success were not given.</td></tr>
<tr><td>TOTAL</td><td>(% of Attributes Commenced)</td><td>64</td><td></td></tr>
</table>

Participant	Description	Criteria		Rating	Comments on Application of Criteria
21	Title: Greenhouse Effect Focus: Ages 14 – 15 Description: The WebQuest involves a group of students researching the Greenhouse effect and developing a PowerPoint presentation on how to reduce the effect of it. Level of Completion: 5/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	4 2 1 **7**	This was a visually appealing WebQuest; however it contained a number of broken links.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	2 2 **4**	The introduction was engaging and effective.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	0 6 **6**	An engaging task that elicits thinking, but was not connected to any standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	4 3 2 **9**	Every step was clearly stated; however some activities did not relate to specifically to the task
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	2 2 **4**	Only some connection between the basic resources and the task.
		Evaluation	Clarity of Evaluation /6	**6**	A detailed evaluation rubric was given.
		TOTAL	**(% of Attributes Commenced)**	**72**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
22	Title: Nemo Alphabet Focus: Ages 5 – 6 Description: This WebQuest requires students in Kindergarten or year 1 to look at the difference between capital letters and small letters Level of Completion: 5/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	2 2 1 **5**	The WebQuest lacked variety in colour and layout and contain broken links.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	1 1 **2**	There were a few places were a learner could get lost and some broken links.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	0 0 **0**	This section was started, but no real content was included.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	2 0 0 **2**	Some steps were given, but they were confusing and did not contain strategies to solve the task.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	0 0 **0**	This section was started, but no real content was included.
		Evaluation	Clarity of Evaluation /6	**n/c**	Section was included but not commenced.
		TOTAL	**(% of Attributes Commenced)**	**20**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
24	Title: It's your Choice Focus: Ages 14 – 15 Description: In this WebQuest students have to research the effectiveness of various global aid organisations and award one of them with aid organisation of the year. Level of Completion: 5/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	2 2 1 **5**	The WebQuest lacked variety in colour and layout and contain broken links.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	1 0 **1**	The introduction did not prepare the learner for what they were about to do.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	0 6 **6**	An engaging task that elicits thinking, but was not connected to any standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	4 3 1 **8**	Every step was clearly stated; however more complex activities which cater for a higher level of thinking were needed.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	2 2 **4**	Only some connection between the basic resources and the task.
		Evaluation	Clarity of Evaluation /6	**3**	The criteria for success were partially given.
		TOTAL	**(% of Attributes Commenced)**	**54**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
25	Title: Faces – Elements of Art Focus: Ages 14 - 15 Description: A group of students imagine that they are museum curators in this WebQuest. The have to research various pieces of art related to human faces. Level of Completion: 5/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	4 4 2 **10**	A beautifully presented WebQuest that was mechanically sound and where the navigation was seamless.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	2 0 **2**	This engaging introduction described a compelling problem, but it lacked direction.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	0 3 **3**	The Task was doable, but it lacked significance and was not connected to standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	4 3 1 **8**	Every step was clearly stated; however more complex activities which cater for a higher level of thinking were needed.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	2 0 **2**	The few resources selected were of poor quality.
		Evaluation	Clarity of Evaluation /6	**6**	The criteria for success were clearly stated.
		TOTAL	**(% of Attributes Commenced)**	**62**	

APPENDIX O

RESEARCHER EVALUATIONS OF PARTICIPANT WEBQUESTS FROM STAGE 5

Participant	Description	Criteria		Rating	Comments on Application of Criteria
26	Title: Diet Related Diseases Focus: Ages 12 - 16 Description: In this WebQuest Students are requested to research a diet related disease and present their findings in a PowerPoint presentation. Level of Completion: 4/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	2 2 2 **6**	No mechanical problems were found, but the WebQuest lacked variety in colour and layout.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	2 1 **3**	The introduction was engaging although it lacked emphasis.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	2 6 **8**	The doable and engaging task was not clearly connected to standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	2 3 1 **6**	Some directions were given, but teaching strategies were insufficient and more complex activities were required.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	2 2 **4**	There was some connecting between the resources and the task, but the resources did not encourage a deeper approach to learning
		Evaluation	Clarity of Evaluation /6	**n/c**	Section was included but not commenced.
		TOTAL	**(% of Attributes Commenced)**	**61**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
27	Title: Diet Related Diseases Focus: Ages 12 – 16 Description: This WebQuest is very similar to participants 26's WebQuest as the two participants worked together, however this WebQuest is not as complete. Level of Completion: 2/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	2 2 2 **6**	No mechanical problems were found, but the WebQuest lacked variety in colour and layout.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	n/c n/c **n/c**	Section was included but not commenced.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	2 6 **8**	The doable and engaging task was not clearly connected to standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	n/c n/c n/c **n/c**	Section was included but not commenced.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	n/c n/c **n/c**	Section was included but not commenced.
		Evaluation	Clarity of Evaluation /6	**n/c**	Section was included but not commenced.
		TOTAL	**(% of Attributes Commenced)**	**70**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
28	Title: Shipwreck and Salvaging Focus: Ages 15 – 16 Description: In this partially completed WebQuest the structure and the mechanical aspects of the WebQuest are sound, however there is no content. Level of Completion: 1/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	2 4 2 **8**	A mechanically sound WebQuest, with working links, although the graphic elements did not contribute to the theme of the task.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	n/c n/c **n/c**	Section was included but not commenced.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	n/c n/c **n/c**	Section was included but not commenced.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	n/c n/c n/c **n/c**	Section was included but not commenced.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	n/c n/c **n/c**	Section was included but not commenced.
		Evaluation	Clarity of Evaluation /6	**n/c**	Section was included but not commenced.
		TOTAL	**(% of Attributes Commenced)**	**80**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
29	Title: Government Focus: Ages 10 – 12 Description: In this WebQuest students in groups of three need to create and govern a small Kibbutz using the software package Sims Town™, and then describe the process. Level of Completion: 5/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	2 4 2 **8**	A mechanically sound WebQuest, with working links, although the graphic elements did not contribute to the theme of the task.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	2 2 **4**	The introduction was engaging and effective.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	2 6 **8**	The doable and engaging was not clearly connected to standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	4 0 2 **6**	The processes were clearly stated, but they lacked the strategies needed to complete the task.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	2 2 **4**	There was some connecting between the resources and the task, but the resources did not encourage a deeper approach to learning.
		Evaluation	Clarity of Evaluation /6	**n/c**	Section was included but not commenced.
		TOTAL	**(% of Attributes Commenced)**	**68**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
30	Title: What Spider is That? Focus: Ages 10 – 12 Description: A partially finished WebQuest where students have to complete a table on the appearance and habitat of two spiders. Level of Completion: 2/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	2 2 2 **6**	No mechanical problems were found, but the WebQuest lacked variety in colour and layout.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	n/c n/c **n/c**	Section was included but not commenced.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	2 3 **5**	The doable task was not engaging, nor was it clearly connected to standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	n/c n/c n/c **n/c**	Section was included but not commenced.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	n/c n/c **n/c**	Section was included but not commenced.
		Evaluation	Clarity of Evaluation /6	**n/c**	Section was included but not commenced.
		TOTAL	**(% of Attributes Commenced)**	**55**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
31	Title: Camp Barclough Focus: Ages 13 – 14 Description: In this partially completed WebQuest groups of students are requested to organise the safety and nutritional requirements for a two day school camp. Level of Completion: 5/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	4 4 2 **10**	A beautifully presented WebQuest that was mechanically sound and where the navigation was seamless.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	2 2 **4**	The introduction was engaging and effective.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	2 6 **8**	The doable task was not engaging, nor was it connected to standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	2 3 1 **6**	Some directions were given, but teaching strategies were insufficient and more complex activities were required.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	2 2 **4**	There was some connecting between the resources and the task, but the resources did not encourage a deeper approach to learning.
		Evaluation	Clarity of Evaluation /6	**3**	The criteria for success were partially given.
		TOTAL	**(% of Attributes Commenced)**	**70**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
32	Title: Shop till you Drop Focus: Ages 13 – 14 Description: This WebQuest requires students to manage a monthly budget. They have to buy food, clothes and pay bills, while recording and justifying their spending. Level of Completion: 2/6 Attributes Commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	2 4 2 **8**	A mechanically sound WebQuest, with working links, although the graphic elements did not contribute to the theme of the task.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	n/c n/c **n/c**	Section was included but not commenced.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	n/c n/c **n/c**	Section was included but not commenced.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	n/c n/c n/c **n/c**	Section was included but not commenced.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	n/c n/c **n/c**	Section was included but not commenced.
		Evaluation	Clarity of Evaluation /6	**3**	The criteria for success were partially given.
		TOTAL	**(% of Attributes Commenced)**	**64**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
33	Title: Design a Food Mall Focus: Ages 13 – 14 Description: This WebQuest revolves around researching food malls in Australia and looking at how they meet the needs of the shoppers, they must also create a signature dish. Level of Completion: 5/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	2 4 2 **8**	A mechanically sound WebQuest, with working links, although the graphic elements did not contribute to the theme of the task.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	2 2 **4**	The introduction was engaging and effective.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	2 3 **5**	The doable task was not engaging, nor was it clearly connected to standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	2 3 1 **6**	Some directions were given, but teaching strategies were insufficient and more complex activities were required.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	2 2 **4**	There was some connecting between the resources and the task, but the resources did not encourage a deeper approach to learning.
		Evaluation	Clarity of Evaluation /6	**n/c**	Section was included but not commenced.
		TOTAL	**(% of Attributes Commenced)**	**62**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
34	Title: Bridges WebQuest Focus: Ages 15 – 16 Description: The Sydney Harbour Bridge is to be demolished in this WebQuest and students in groups of 3 have to design and justify a new iconic bridge for the city. Level of Completion: 3/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	2 2 2 **6**	The WebQuest was mechanically sound, however the external navigation was confusing and the design lacked colour and variety.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	n/c n/c **n/c**	Section was included but not commenced.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	2 3 **5**	The doable task was not engaging, nor was it clearly connected to standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	4 3 1 **8**	Every step was clearly stated; however more complex activities which cater for a higher level of thinking were needed.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	n/c n/c **n/c**	Section was included but not commenced.
		Evaluation	Clarity of Evaluation /6	**n/c**	Section was included but not commenced.
		TOTAL	**(% of Attributes Commenced)**	**59**	

<table>
<tr><th>Participant</th><th>Description</th><th colspan="2">Criteria</th><th>Rating</th><th>Comments on Application of Criteria</th></tr>
<tr><td rowspan="7">35</td><td rowspan="7">Title: The Planet Mars

Focus: Ages 13 – 14

Description: In pairs, students imagine they have been selected to go on a journey to Mars. The students have to research as much as possible before they go and present their findings.

Level of Completion: 5/5 attributes commenced.</td><td>Overall Aesthetics</td><td>Visual Appeal /4
Navigation /4
Mechanical Aspects /2
Sub-Total /10</td><td>2
4
2
8</td><td>A mechanically sound WebQuest, with working links, although the graphic elements did not contribute to the theme of the task.</td></tr>
<tr><td>Introduction</td><td>Motivational Effectiveness /2
Cognitive Effectiveness /2
Sub-Total /4</td><td>1
1
2</td><td>There were a few places were a learner could get lost and some broken links.</td></tr>
<tr><td>Task</td><td>Connection of Tasks to Standards /4
Cognitive Level of Tasks /6
Sub-Total /10</td><td>2
3
5</td><td>The doable task was not engaging, nor was it clearly connected to standards.</td></tr>
<tr><td>Process</td><td>Clarity of Process /4
Scaffolding of Process /6
Richness of Process /2
Sub-Total /12</td><td>4
3
1
8</td><td>Every step was clearly stated; however more complex activities which cater for a higher level of thinking were needed.</td></tr>
<tr><td>Resources</td><td>Relevance & Quantity of Resources /4
Quality or Resources /4
Sub-Total /8</td><td>2
2
4</td><td>There was some connecting between the resources and the task, but the resources did not encourage a deeper approach to learning.</td></tr>
<tr><td>Evaluation</td><td>Clarity of Evaluation /6</td><td>n/c</td><td>Section was included but not commenced.</td></tr>
<tr><td>TOTAL</td><td>(% of Attributes Commenced)</td><td>63</td><td></td></tr>
</table>

Participant	Description	Criteria		Rating	Comments on Application of Criteria
36	Title: IN4MUS (inform us) Focus: Ages 13 – 14 Description: IN4MUS is a WebQuest design for year eight technology students. The WebQuest guides them through the process of developing a webpage. Level of Completion: 3/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	2 2 2 **6**	The WebQuest was mechanically sound, however the external navigation was confusing and the design lacked colour and variety.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	n/c n/c **n/c**	Section was included but not commenced.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	2 3 **5**	The doable task was not engaging, nor was it clearly connected to standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	4 3 0 **7**	Every step was clearly stated; however more complex activities which cater for a higher level of thinking were needed.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	n/c n/c **n/c**	Section was included but not commenced.
		Evaluation	Clarity of Evaluation /6	**n/c**	Section was included but not commenced.
		TOTAL	**(% of Attributes Commenced)**	**56**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
37	Title: Australia – You're Running Around it. Focus: Ages 10 – 12 Description: This WebQuest guides students through the process of collating the collective kilometres run during exercise time and plots them on a map of Australia Level of Completion: 4/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	2 2 2 **6**	The WebQuest was mechanically sound, however the external navigation was confusing and the design lacked colour and variety.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	n/c n/c **n/c**	Section was included but not commenced.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	2 6 **8**	The doable and engaging task was not clearly connected to standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	2 3 1 **6**	Some directions were given, but teaching strategies were insufficient and more complex activities were required.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	2 2 **4**	There was some connecting between the resources and the task, but the resources did not encourage a deeper approach to learning.
		Evaluation	Clarity of Evaluation /6	**n/c**	Section was included but not commenced.
		TOTAL	**(% of Attributes Commenced)**	**60**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
38	Title: Video Camera Techniques Focus: Ages 13 – 14 Description: This WebQuest is aimed towards technology students in years seven and eight and it guides them through the process of making a movie of their choice. Level of Completion: 5/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	4 4 2 **10**	A visually appealing WebQuest, that was in complete working condition.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	2 2 **4**	The introduction was engaging and effective.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	2 3 **5**	The doable task was not engaging, nor was it clearly connected to standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	2 3 1 **6**	Some directions were given, but teaching strategies were insufficient and more complex activities were required.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	2 2 **4**	There was some connecting between the resources and the task, but the resources did not encourage a deeper approach to learning.
		Evaluation	Clarity of Evaluation /6	**3**	The criteria for success were partially given.
		TOTAL	**(% of Attributes Commenced)**	**64**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
39	Title: A Day in the Life of a Fireman Focus: Ages 7 – 8 Description: This WebQuest gets students to imagine that they are volunteers for the local rural fire service, and they have to read a diary entry for a fiery summer's day. Level of Completion: 3/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	2 4 2 **8**	A mechanically sound WebQuest, with working links, although the graphic elements did not contribute to the theme of the task.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	n/c n/c **n/c**	Section was included but not commenced.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	2 3 **5**	The doable task was not engaging, nor was it clearly connected to standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	2 3 0 **5**	Some directions were given, but they were insufficient to solve the task.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	n/c n/c **n/c**	Section was included but not commenced.
		Evaluation	Clarity of Evaluation /6	**n/c**	Section was included but not commenced.
		TOTAL	**(% of Attributes Commenced)**	**56**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
40	Title: Aussie Animals Extinct Focus: Ages 7 – 8 Description: In this WebQuest students assume they are members of the Protect Oz Animals Society and they have to create a presentation supporting an endangered species exhibition Level of Completion: 5/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	2 4 2 **8**	A mechanically sound WebQuest, with working links, although the graphic elements did not contribute to the theme of the task.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	1 1 **2**	There were a few places were a learner could get lost and some broken links.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	2 3 **5**	The doable task was not engaging, nor was it clearly connected to standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	4 3 1 **8**	Every step was clearly stated; however more complex activities which cater for a higher level of thinking were needed.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	2 2 **4**	There was some connecting between the resources and the task, but the resources did not encourage a deeper approach to learning.
		Evaluation	Clarity of Evaluation /6	**n/c**	Section was included but not commenced.
		TOTAL	**(% of Attributes Commenced)**	**61**	

Participant	Description	Criteria		Rating	Comments on Application of Criteria
41	Title: Cooperating Communities WebQuest Focus: Ages 10 – 12 Description: In this WebQuest students imagine they work for a relocating company and they have to find the best home town in Australia and present their findings. Level of Completion: 5/5 attributes commenced.	Overall Aesthetics	Visual Appeal /4 Navigation /4 Mechanical Aspects /2 **Sub-Total /10**	2 4 2 **8**	A mechanically sound WebQuest, with working links, although the graphic elements did not contribute to the theme of the task.
		Introduction	Motivational Effectiveness /2 Cognitive Effectiveness /2 **Sub-Total /4**	1 1 **2**	There were a few places were a learner could get lost and some broken links.
		Task	Connection of Tasks to Standards /4 Cognitive Level of Tasks /6 **Sub-Total /10**	2 3 **5**	The doable task was not engaging, nor was it clearly connected to standards.
		Process	Clarity of Process /4 Scaffolding of Process /6 Richness of Process /2 **Sub-Total /12**	2 3 1 **6**	Some directions were given, but teaching strategies were insufficient and more complex activities were required.
		Resources	Relevance & Quantity of Resources /4 Quality or Resources /4 **Sub-Total /8**	n/c n/c **n/c**	Section was included but not commenced.
		Evaluation	Clarity of Evaluation /6	**3**	The criteria for success were partially given.
		TOTAL	**(% of Attributes Commenced)**	**57**	

APPENDIX P

Peer Review of Research

The following publications and presentations enabled aspects of the thesis to be open to public scrutiny and comment during preparation:

Referred Conference Proceedings

Cotton, W., Lockyer, L., Brickell, G., & Harper, B. (2004) The Design of Performance Support Systems to Contextualise Generic Learning Designs, *Proceedings of ED MEDIA 2004 - World Conference on Educational Multimedia, Hypermedia and Telecommunications*, Association for the Advancement of Computing in Education (AACE) , Norfolk, USA , pp.476-482 .

Cotton, W., (2008) Supporting the use of learning objects in the K-12 environment: A design-based research project, *Proceedings of the Emerging Technologies Conference*, University of Wollongong, 18-21 June 2008

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