2005

An exploration of student performance, utilization, and attitude to the use of a controlled content sequencing web based learning environment

Justin A. Brown
Edith Cowan University

Edith Cowan University

Doctoral Dissertation

An Exploration of Student Performance, Utilization, and Attitude to the use of a Controlled Content Sequencing Web Based Learning Environment.

A thesis submitted to the Graduate School in partial fulfilment of the requirements for the

Degree of Doctor of Philosophy and Information Science

By

Justin Brown

Principal Supervisor: Dr. Arshad Omari

School of Computer and Information Science
Faculty of Computing, Health and Science
Edith Cowan University, Western Australia

COPYRIGHT AND ACCESS DECLARATION

The Use of Thesis statement is not included in this version of the thesis.

ABSTRACT

Universities, traditionally places of teaching and research, have seen and are continuing to see radical changes occur in the area of teaching and the methods of teaching delivery. The World Wide Web, or 'Web' has begun to subsume the classroom as the preferred means by which students access their tertiary learning materials, and ultimately, how academic staff deliver those materials. The delivery of learning via the Web takes many forms and is generically, and usually inaccurately, referred to by such names as e-learning, online learning, web-based training and web based education, using such technologies as virtual learning environments, learning management systems and learning content management systems. This study focuses specifically on the delivery of electronic learning materials in the support of both in-class and online teaching.

> "Because providing learners with control requires an ability to self-regulate behaviour, whereas program control does not, it seems important for research to examine the interaction between SRLS and the type of instructional control provided in CBI lessons" (J. Young, 1996, p.19)

The purpose of this study was to examine the role of Controlled Content Sequencing (CCS) in the delivery of learning materials via the Web. This research arose from perceived issues in delivering learning materials by an existing learning content management system, referred to in this work as the eLCMS, with students appearing to selectively utilise the unit learning materials they were provided with via the eLCMS. Once students had downloaded the learning materials, it was effectively impossible for staff to ascertain if the students were actually working with the materials, and if so, what value they were getting from them. To this end, the Controlled Content Sequencing approach was developed, where students received highly structured, sectionalised learning materials with associated learning assessments, with the requirement that students perform well in these assessment to gain access to a following section of content. If students did not perform well within a section of content, they were required to repeat the materials a second time. Scores for each assessment were

presented to students in the study, as were messages and study hints congruent to their assessment scores.

The study utilised a two group experimental method using Pre and Post tests to compare the learning performance of students using the normal eLCMS and materials, against those using the CCS content delivery method with the re-authored CCS specific materials. While the learning materials contained the same content, the CCS content was re-designed for delivery in a structured, controlled sequence. Both groups had their usage of the respective systems monitored through a clickstream, which essentially tracked their movements within the systems and their access to the learning content. After completing the learning materials within their respective systems, both groups filled in an online survey regarding their attitudes towards the systems. Staff members were presented with a detailed description of the CCS system and its underlying principles, after which they were asked to comment on its possible benefits to their teaching practice. Results of the study indicated that the treatment group using the CCS system performed significantly better than the control group using the eLCMS system, a result attributed to the content design, structure, assessments and control features of the CCS system. Students using the CCS system spent longer working with the learning materials overall, and were required to work with all materials, not just the items they wanted to use. Students within the treatment group indicated that they were in favour of the structure, content design and assessment elements of the CCS system, but were somewhat less enthusiastic about the control it imposed upon access to the unit learning materials. Staff members indicated that they would like to have more control over how students access the online learning materials, though the issue of system management and student complaints about the control elements were raised as staff concerns.

The outcome of the study indicates that for the delivery of online learning materials, the addition of control to the process can produce improved student learning outcomes, and that while some students will look for shortcuts around control mechanisms, exposure to all learning materials at least once is still more beneficial to them than only some of the materials once.

DECLARATION

I certify that the thesis does not, to the best of my knowledge and belief:

(i) incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher degree;

(ii) contain any material previously published or written by another person except where due reference is made in the text; or

(iii) contain any defamatory material.

Signed __________________

Date ____________________

TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

Chapter 1

1.0 Introduction

This research investigates the attitudes of students and staff in a university school of computing to the use of Controlled Content Sequencing (CCS) of learning materials in an online content management system. At the time of the study the school in question was using an in-house content management system that will be referred to as the existing Learning Content Management System (eLCMS), designed for the purpose of delivering lecture, workshop and reading materials to enrolled students via the web. Forums, unit messages, links to online resources and documents were all available through the system, with a requirement that all units being taught in the school, be they on-campus, online or mixed mode, be available through the system. Though the eLCMS allowed for some customisation in content layout, essentially the system was a hybrid between a document management system and a Learning Content Management System (LCMS), designed to support on-campus and online teaching. Aside from being able to set the visible status of each week's worth of content, and individual pieces of content within each week, (also referred to as a module), staff members had no control over the sequence in which students accessed the learning materials within the system, and once downloaded to the student's PC, how they worked with them locally. The aim of this research focussed on applying control to the way in which students both accessed and used the online learning materials, primarily to investigate learning performance benefits as well as staff and student reaction to such control, where none had existed before.

The eLCMS system had evolved within the school to meet the specific needs of the school's teaching programs, such as immediacy, accessibility and quality control,. The eLCMS essentially allowed staff the ability to quickly and easily upload learning materials to the web, and students to have ready access to those materials. Students reacted positively to the ready access to content that the system provided, though after several semesters of use, the system appeared to have engendered an expectation in students that all the learning materials for a given unit of teaching should be available at the beginning of a semester. While students indicated that they wanted all materials available at the beginning of semester, it seemed less apparent that students were actually using all the materials in an effective manner. Anecdotal evidence suggested that many students selectively read and reviewed materials directly related to unit assignments, but that other material, such as lectures and readings, were deferred until late in the semester, at which point they would be studied during exam preparation.

1.1 Statement of the problem

This research evolved from initial investigations into rule-based systems for use in delivering learning materials via the web, with work being carried out on a rule-authoring environment that would allow instructors to design multi-level conditional rules for each learning item in an online course (Brown, 2002). These rules would examine each student's usage pattern of the online content, along with performance data on content specific assessments, to determine access to each individual piece of learning content, each week's worth of content and eventually, an entire semester's worth of content. The system was not designed to dynamically re-sequence content, or introduce new content of varying difficulty according to a student's perceived level of understanding. The original system was designed to allow staff to work with a system structurally similar to the eLCMS, but with the ability to add rules for content access. The impetus for developing an online environment with an integrated rule engine arose from perceived issues in delivering content using the eLCMS (Brown, 2003). When working with students in lectures, workshops or assisting with assessments, it appeared that students were selectively acting upon some of the learning content, and ignoring other materials. This student behaviour was not representative of all students, though it was common enough across a number of semesters, teaching different content in different units, to be noticeable.

It was thought that one of the reasons for this problem being more apparent than in previous years might have been related to the lack of proximity that the eLCMS and systems like it can create (Chabonneau, 2005), as students see the system as being online learning, rather than a tool that supports existing teaching and learning. The materials placed within the eLCMS were designed to be delivered either in a class-room setting, or through a structured online teaching programme. As the eLCMS allowed students to access learning materials outside of normal teaching environments, the tendency for students to see the learning materials as their only source of contact with a unit increased. While working independently of the university environment can work for some students, it can prove problematic for others.

> "While an online method of education can be a highly effective alternative medium of education for the mature, self-disciplined student, it is an inappropriate learning environment for more dependent learners. Online asynchronous education gives students control over their learning experience, and allows for flexibility of study schedules for non traditional students; however, this places a greater responsibility on the students. In order to successfully participate in an online program, student must be well organized, self-motivated, and possess a high degree of time management skills in order to keep up with the pace of the course." (ION, 2005)

It was felt that by integrating rules into the content delivery model that required students to interact with all weekly learning content, a higher level of proximity between the students and the learning content could be engendered.

As the development work on the original rule-based system came closer to being applied beyond experimental purposes, questions about the system arose through interaction and consultation with staff and students. Would the system actually benefit the intended target user population? Would staff find the ability to author and apply rules for access and progress on web based learning materials desirable, or even useful? Would students react positively or negatively to the application of rules for access to and progress through their weekly and semester learning materials? Finally, would the addition of rules for content access and delivery actually benefit student learning and performance outcomes? These questions were drawn into an overall question, i.e. whether rules for controlling online content sequencing would be useful in the context of a university environment already making heavy use of the web for learning content delivery.

When the literature on e-learning and online learning was examined in order to address this question, it became apparent that a gap existed in the research field from the point of view of giving course and content author's control of their student's web based learning environment. The literature was primarily focussed on web based learning content delivery from a student-centred perspective, where the WWW is used to deliver learning materials to students, who are then responsible for using that content effectively at their end. This literature was replete with examples of how online course delivery systems had helped students engage with their course materials, and had fostered interaction with staff members and fellow students via various online tools. The literature seemed to indicate excitement by authors regarding the possibilities of the web as a medium for enhancing student satisfaction with their university learning experience, yet the role of the academic staff member, the author of courses and the content contained within, seemed largely peripheral to the discussion. The tricks and traits that academic staff members had developed over periods of years or even decades of teaching their course content, for gauging their student's progress and for re-enforcing critical concepts was noticeably absent from the list of topics deemed important in the literature. Friedland and Pauls (2005) touch on the experience and expertise of the teacher when stating that “an excellent teacher should remain excellent whether aided by electronic devices or not” and that “any tool must thus ensure that it conforms to the teacher’s established working habits while adding value to the teaching experience. Given that every teacher has a different perception of what constitutes a good lecture, instructors must be able to change tools according to their preferences and ideas”. Content delivery within the literature was often discussed in relation to learning content within online courses, these courses being driven by a single pedagogical model. Literature examining content rather than course delivery, where individual teaching staff could decide how content was delivered to their students according to their own pedagogical leanings, was underdeveloped. As Karampiperis and Sampson (2005, p. 391) state “In automatic course sequencing, the main idea is to generate a course suited to the needs of the learners”. For this research, the idea was to sequence and control content delivery rather than the course, and to allow the sequence to be generated by the content authors rather than the students. The overall goal was the same, to benefit learners, particularly in terms of learning performance.

The area of hypermedia systems was rich in research regarding advanced learning environments that could react to individual students according to their usage patterns and performance in online assessments. Rather than controlled, author-centred rules for linear progress through a highly specific set of materials, this field was mainly concerned with modelling learning content, modelling individual students, to allow for dynamic re-sequencing of course content, from a difficulty and media format perspective, based on each student’s progress through a course of learning materials (Baldoni, Baroglio, Henze, & Patti, 2002; Brusilovsky, 2000a; De Bra, Brusilovsky, & Houben, 1999; Eklund, 1995; Eklund & Brusilovsky, 1998). While informative from a technical perspective and abundant with rule-based systems, this literature did not address the problem of whether a CCS like system would be acceptable and practical in the teaching environment in which this study was based.

The concern of high content access but low content utilisation led to the question of whether a controlled approach to content delivery might lead to a more consistent interaction between students and the online learning content, which may in turn lead to better student learning performance. "I suspect that the WWW is an ideal medium for good self-regulators, but that it will turn out to be a deadly place for poor self-regulators. This hypothesis may be worthy of experimentation" (Brooks, 1997, p3).

1.2 Background to the study

The use of the World Wide Web (WWW) as a delivery medium for learning content, regardless of the shape or form (text, images, video, documents) is changing, or more likely, has changed the way in which traditional educational and training environments operate. As Ring (1998) states "Educational organisations, particularly at secondary and tertiary level, are making increasing use of the WWW to deliver courses, to access global resources and to provide learning support for students". In the environment in which this research was conducted, the WWW had moved from a novel document delivery tool used by lecturers with the appropriate skills (for their classes only), to the central delivery mechanism for an entire school's teaching program. The development and evolution of this system was driven at multiple levels, from the I.T. staff who began the initial systems development, to input from lecturing staff and administrators responsible for working with and instituting university teaching policy.

The university in question had adopted an online learning approach throughout all faculties, though not all faculties and schools used the same environment. The Blackboard system was used throughout the university, and supported in excess of 28000 users enrolled in units across the entire university. WebCT was used by one of the larger schools, while yet another faculty used a combination of these systems and their own in-house developed system. The reasons for the non-homogenous use of a central LMS solution is beyond the scope of this research, and is primarily cited to illustrate the level to which the university environment had become reliant on the WWW for content delivery and student learning support.

The eLCMS system supported 2177 students enrolled across 116 active teaching units, those units ranging from 1st year to postgraduate level. There were 7500 'active objects' in the system, including links, documents, messages and weeks/modules within unit schedules. The average number of log-ins per day, which included semester breaks and shutdown periods, was 1600. These basic statistics show the level of utilisation for the eLCMS system and shape the reasoning behind performing research within this user community before actively moving towards a system that strives to improve content utilisation, without the intention of alienating students who are used to unfettered access to that content.

1.3 Purpose and rationale of the study

This study primarily focussed on usage of and reactions to the application of control mechanisms for access to online learning materials via a WWW based learning content management system. Taking into account Brook's (1997, p.14) statement "curriculum materials that force students to respond, to make choices, to perform, to organize, to think deeply about material, and so forth, have better outcomes, generally, than ones in which they just read or listen", one of the key underlying attributes of this research was to create an environment which required, not asked, students to engage with learning materials at a specific time, if not a place. As the eLCMS made student's access to materials easier and routine, it also reduced proximity to both the learning environment (lectures and workshops) and the time frame in which the learning content was 'expected' to be completed. Brooks (1997, p. 135) reflects these concerns when stating that "after all, instructors can do only so much to improve their teaching before the lack of student involvement becomes a limiting factor". This study aimed to increase student involvement with the learning materials by providing control and structure, control in terms of content access and sequencing, structure in terms of logical grouping of learning materials according to topic.

> "Presentation sequences provide a consistent, high-quality explanation to all learners. They work well for teaching established information in a highly efficient way to many people. Presentation sequences allow the designer to control the order of learning actions experienced by the learner. Use them where designers really do know the best way to teach certain material" (Horton, 2000, p. 199)

A significant body of literature exists discussing the concepts of learner motivation and the relative benefits/drawbacks of learner controlled learning verus program controlled learning. This literature, evolving from the introduction of Computer Based Instruction (CBI) systems of the 1970's onwards (Eom & Reiser, 2000), attempts to measure the outcomes of learning scenarios where one group of users control their own learning decisions, whilst others have the learning decisions controlled for them and all they have to do is actually learn.

> "In contrast to classroom instruction, e-learning can allow learners to select the topics they want, control the pace at which they progress, and decide whether to bypass some lesson elements such as examples or practice exercises. When learners have the option to make these kinds of choices, we say the instruction offers learner control. In contrast, when the course and lesson offer few learner choices, the instruction is under program control" (Clark & Mayer, 2003, p. 227)

In this research, the aim was not to conduct another study comparing and contrasting learning styles, but to use these studies as a framework for examining how users, in a well established and known environment, reacted to having program controlled learning techniques interlaced with their existing online learning environment.

1.4 Definitions of terms

The field of e-learning or online learning is rich with terminology. Web Based Education (WBE), Web Base Training (WBT), Learning Management Systems (LMS), Learning Content Management Systems (LCMS), Content Management Systems (CMS). These are just a few of the terms used to describe the placing of learning related content on the WWW, and though each term does have its own domain of endeavour, many of these terms are used interchangeably in the literature.

In addition, a significant amount of technical literature exists that covers learning design and strategies for online and Computer Based Education (CBE). Adaptive Hypermedia (AH) and Adaptive Hypermedia Systems (AHS), Intelligent Tutoring System (ITS), Computer Based Training (CBT), Computer Assisted Learning (CAL) and Computer Based Learning (CBL). Other relevant terms to this study include Program Control (PC) and Learner Control (LC) based learning, which have linkages to the field of research known as Self-Regulation (SR) and Self Regulated Learning Strategies (SRLS). This research was developed from the literature covering all these areas, and more in-depth discussion of their meanings within the study's context will be presented in the following chapter, Literature Review. For the purposes of this study, the following terms will be used regularly.

Assignment: an assignment is a required piece of coursework which students complete in order to gain marks towards passing a unit. Generally a unit consists of two or three assignments and an end of semester exam.

CCS System: this was the system designed to test specific elements of Controlled Content Sequencing as derived from the literature on e-learning, adaptive hypermedia and computer based instruction. The system was designed to deliver learning materials within a WWW programming unit. The system divided lectures, reading and workshop into sections, with assessment and feedback between each item and the sections as a whole.

Course: a course is an undergraduate or postgraduate award generally consisting of a number of unique units taught over a number of semesters.

eLCMS: this was a system designed in-house by the school featured in this research for the purpose of delivering lecture, workshop and reading based learning materials to on-campus and online-based students. The system also featured bulletin boards (or forums) that were teaching, research and social specific, as well as online assessment submission. The eLCMS allowed lecturers to present weekly content as part of the unit schedule, allowing students to click and read or click and save visible items in any order they desired.

Lecture: typically, an on-campus event where all students enrolled in a unit are expected (though not explicitly required) to attend. Lectures cover the theoretical elements of a unit as a whole, and each weekly lecture usually covers a specific sub-topic of the larger domain of knowledge from which the unit is constructed. In the unit used for this research, weekly lectures cover specific topics related to the concepts of WWW programming, project management, networking infrastructure and security.

Lecturer: a lecturer is a member of the academic staff who is responsible for authoring unit content, including lectures and workshops, presenting the weekly lectures and some of the workshops (most units have multiple workshops due to class sizes).

Reading: contains a number of required and recommended readings, from unit textbook(s), journals or WWW sites. The readings usually provided further in-depth coverage of the weekly topics raised in the lectures, but can also relate specifically to workshops and assignment work

School: within the university in question, a school exists with a faculty and is an area within which specific disciplines are taught and researched, in this case, computing and information science.

Unit: a unit is a subject that is taught over the period of a semester, with a semester encompassing 12-13 teaching weeks normally followed by an examination.

Unit Co-ordinator: Unit Co-ordinators are lecturers who are responsible for overseeing units and placing content into the eLCMS system.

Workshop: a workshop typically takes place in a computer laboratory where students work on the practical aspects of a unit. Typically, workshop materials take students through the concepts required to complete their semester assessments. In the unit used for this research, weekly workshops covered such topics as client side programming techniques, server side programming techniques, database servers and database development, applications programming and code debugging/system testing.

1.5 Statement of the research question

The purpose of this study was to identify student and staff reactions to the placing of control structures into a content management system used for the delivery of learning materials within a university computer and information science school. The primary research question was;

Would controlled content sequencing be a useful delivery method for web-based university learning materials?

The primary research question was addressed through the exploration of three supporting questions that defined the specifics of the overall question. The first of these supporting questions examines the performance issues associated with students using the rule-driven CCS system, in this case performance being used in the context of assessment instruments used within the study.

1.5.1 Supporting question one

Is there a measurable difference in student learning performance between those using Controlled Content Sequencing (CCS) and those that do not?

The underlying framework for this research relied heavily on design and best practice examples from the literature and the researcher's experience in both in-class and online teaching to provide guidance as to how the learning content should be organised and delivered. This framework relies on individual sections containing topic specific content, interleaved with assessments to analyse and control student progression through the learning materials. Pope (2001, p. 127) alludes to such control mechanisms when stating;

> "An assessment immediately following the self-paced Web-based Introduction to Networking would have been helpful to gauge the learner's progress and determine if they were prepared to continue with the program".

A two group experimental design was used to compare the learning performance outcomes between students using the eLCMS and the CCS systems, while attitudinal data to these systems was gathered from both groups of students as well as members of academic staff within the school. Within this design, the students using the eLCMS would effectively be within a learner controlled environment, while the CCS system users would be working within a program controlled environment.

> "Although theorists have insisted that learners should be given some degree of control over instruction, the results of learner control studies in CBI have not fully supported the effectiveness of learner control". (Eom & Reiser, 2000, p. 247)

These authors examined the relationship between students' self-regulation capabilities with respect to learning and the actual outcomes of using self-regulated, or learner-controlled, delivery strategies. The research conclusions drawn by these authors indicate that there is a gap between student appraisals of their own self-regulated learning skills versus their actual utilisation of learner-controlled systems. Some of the dependent variables identified by Eom and Reiser have been integrated with this research to gain an insight into the relationship between student performance and student utilisation of the CCS (and to a lesser degree, the eLCMS) systems.

> "Dependent variables for this study were the learner's achievement on a post-test, their level of motivation, the amount of time spent on the CBI lesson, and the

number of instructional events viewed by learners in the learner-controlled condition" (Eom & Reiser, 2000, p. 251)

1.5.2 Supporting question two

The second supporting research question was designed to examine the usage patterns associated with the CCS system, from the perspective of how students interacted with the system and learning materials.

What effect does Controlled Content Sequencing have on student usage of online learning materials?

Primarily, this question aimed to investigate whether the CCS method of content delivery changed the way in which students interacted with their weekly learning materials, as compared with students using the eLCMS. Usage patterns that were examined included log-in/log-out events, time spent on and number of clicks on each learning item before moving to and completing the associated assessment. Time spent on each assessment item, the number of attempts required at each section of content, and the answers provided at each attempt at an assessment were also recorded in order to build a profile of how the student participants utilised the CCS system and materials, and what, if any impact such usage behaviour might have had on their overall learning performance (Unfred & Crooks, 2001).

1.5.3 Supporting question three

This final supporting question aimed to establish the popular and unpopular design elements integrated into the CCS system. While the primary interest existed in student and staff reactions to the actual control aspect of the CCS, attitudes towards the content, structure, assessments and material formats were also sought.

What design attributes and implementation factors affect student and staff reaction to Controlled Content Sequencing?

How would students react to CCS, and what aspects of it did they see negatively and positively? Would continuous assessment become tedious for students, or perhaps demoralising if they failed them? Conversely, would students appreciate on-going, content specific assessment that provided them with an indication as to their study progress? Perhaps some students would gain confidence from such regulation of the learning environment. Students might not have wished to participate, even if the controlled sequencing assisted with their learning outcomes, in what Schank (2002, p. 173) refers to as "castor oil content – it doesn't taste good, but it's good for you". The heavy integration of assessment into CCS is in part supported by Garrison and Anderson (2003, p. 93);

> "Assessment is directly linked to effective teaching and learning by revealing understanding and achievement. For this to happen assessment must first be congruent with intended learning outcomes."

The sequential model used within the CCS system produced a weekly content map, showing the students available items, completed items and items not yet available (see “Appendix A – Systems”). This structure was similar to work described by Clark and Mayer (2003, p. 229), who state that “to help learners track progress within a course, it is common to highlight modules, lessons, or topics that have been completed”.

Given the diversity of the student population found in any given unit of teaching in any given semester, it could be that certain aspects of the CCS method would be embraced by some and rejected by others. While a survey mechanism was designed to gather student reactions against a set number of criteria, such as their usage of the existing eLCMS, their usage of the CCS and their open ended responses to likes/dislikes with the respective systems, other data was necessary to put these responses in perspective with the data gathered from questions one and two. To this end, the clickstream (Montgomery, Li, Srinivasan, & Liechty, 2004) data of the CCS user group was used as a comparison point between their attitudinal response and their actual utilisation of the system.

This final question also examined the attitudes of staff to both the existing eLCMS and the concepts embodied in the CCS system. Staff members were surveyed according to their usage of the eLCMS system and the impact it had on their unit teaching. After receiving a detailed description of the CCS system, staff members were then asked to provide feedback as to how they perceived the potential usefulness of the CCS system within their own teaching practice.

1.6 Significance of the study

This study is significant in that it examines the outcome of applying elements of control and structure to the delivery of online learning materials, those outcomes being measured in terms of student learning performance, student utilisation of a controlled system and student reactions to such control. The aim of the research is to provide a guide as to the effectiveness of applying control to the delivery of online materials where previously no control had been in place, and whether by being required to interact with learning materials, rather than being asked to, students gain greater benefit from those learning materials. This research examines online learning and content delivery from the teacher/instructor perspective rather than from the more traditional student-driven approach. There is evidence that when presented with choice and easy access to learning materials (in this case via the WWW), students can under utilise such learning materials and perform more poorly than if placed within a more controlled, structured learning environment (Brooks, 1997; Darbhamulla & Lawhead, 2004a, 2004b; Horton, 2000, 2002; D. Young & Ley, 2003; Zimmerman & Martinez-Pons, 1990).

This research is seen as existing between the fields of content delivery for online learning and adaptive, expert-system driven online learning environments. While a number of elements from both these fields have driven the design and development of the CCS approach to content delivery, it is the matter of content control that is seminal to this work. This research was designed to serve as framework against which a possible evolution of systems like the eLCMS could be take place.

1.7 Organisation of this thesis

This introduction to the thesis has presented the background and rationale for conducting this research, including the research questions and the significance of this work. Chapter 2, Literature Review, will outline the literature upon which the theoretical underpinnings of this research was originally drawn, focussing on evolution of e-learning environments and instructional methods used in conjunction with computer and network based systems. Chapter 3, Methods and Design, will outline the primary research and experimentation methods used to conduct this research. The analysis of collected data will span two chapters; Chapter 4 presenting the performance and usage data analysis of the control and treatment groups, and Chapter 5 showing the analysis of the attitude data returned from both students and staff. Chapter 6 discusses the results of the data analysis in context of the primary and supporting research questions, leading into the concluding statements.

Chapter 2

2.0 Literature Review

The diversity and breadth of literature relating to the integration of computer systems, education and training and the internet is almost as large as the variation in opinions and research goals of those who publish on these subjects. The application and integration of education theory and pedagogy, the development of adaptive, dynamic systems that tailor themselves to the strengths and weakness of each individual user and the transposition of existing learning materials into large-scale, managed learning environments are the three primary areas from which supporting literature was drawn. An in-depth description of all the different sub-topics of these research areas is beyond the scope of this literature review, as is the history and evolution of computer based learning through to online learning systems. The literature presented here focuses specifically on the elements of each of these large research areas that are directly related to this research, from the features included in the CCS system to the logic driving those decisions.

The structure of this chapter is divided into five main sections, Definitions of E-Learning, Content versus Course Delivery, Modelling the Learner and the Content, Course and Content Sequencing Techniques, How Learners Perceive and React to Online Learning. Each section contains a number of sub sections designed to specifically detail those areas that were of relevance to this research. The structure of this chapter is designed to convey the framework from which this research was developed, that is, a foundation in the online and e-learning environment for learning content delivery, with the addition of more advanced control and presentation methods to that delivery.

The field of online learning is central to this research as it is the area in which the stated research problem arose, that is, extending and testing the capability of an existing online learning environment. By examining the literature on the use and application of online learning systems, methods and approaches being used by other researchers and developers could be integrated into the test system developed for this research. The systems that typically appear in the literature involve either Commercial Of The Shelf (COTS) (Grutzner, Angkasaputra, & Pfahl, 2002) systems, such as Blackboard or WebCT, or in-house developed systems designed to meet specific organisational or research needs. Examination of how other researchers and organisations are using these types of systems, and in what context, was an important first step to gaining a more comprehensive perspective on the theoretical and practical drivers within the field of online and e-learning. Areas of particular interest within this literature included the way in which content in these online systems was stored, managed and presented to students, including the access model (synchronous or asynchronous). The types of content, such as electronic learning materials like slideshows, word processed documents or HTML was examined, as were the more current developments of COTS Learning Objects (LO's) that can be slotted into compatible online learning environments.

While the literature on online and e-learning covered the more 'generic' area of placing learning materials online and delivering them as a course of content to students, the literature on adaptive systems was examined in reference to the research dealing with the change in content accessibility and structure according to dynamic rules and conditions. Within this research the field of adaptive systems is examined from two perspectives, adaptive hypermedia systems and WWW based adaptive systems. Before the advent of the internet and WWW as a delivery medium for computer based learning, a significant amount of research had been conducted with hypermedia systems, where conceptually linked electronic information such as images, sounds, movies and text were placed into an environment designed so as to let users explore a domain of knowledge. These hypermedia systems were generally run on stand-alone computers or locally networked environments, and through their focus on interface design, non-linear structure and media rich content were the precursors of the types of environments currently evolving in the area of online and e-learning environments. Adaptive hypermedia is a development of hypermedia, adding complexity to the content management and presentation model by designing the systems to change the difficulty level and types of learning materials available to users according to a performance metric encoded in the system. Many adaptive hypermedia systems drew on artificial intelligence and expert systems research in order to allow the system designers to create models of student learners and the domain content contained in the system. By using in-built quiz and assessment tools these systems could alter the type, level and amount of learning content a student could access according to the underlying instructional model built into the system. Later, when the WWW became prominent as a content delivery medium, researchers began developing WWW based adaptive systems built on the same principles as the hypermedia, adaptive hypermedia and intelligent tutoring system models. This literature was critical to this study due to the amount of research that had been conducted over the last 10-20 years, leading to a large number of innovative system implementations and usage outcomes from which this work could draw. In particular, interface design, content structure and positioning, methods for content control and sequencing were all covered in various studies over a number of different systems. From this literature came the various elements that drove the design of the CCS system for this research, creating a link between the online and e-learning content management concepts and how to apply system control over that content according to a student's performance within the learning materials.

While the mechanics of controlling content and the means of that control is extracted from the literature on adaptive systems, the field of sequencing in the delivery of learning materials also requires discussion. On the face of it, the concepts involved in adaptive systems would appear to be very similar to those involved in the field of content sequencing, they are in fact quite different. Adaptive systems model content and learners, applying complex expert system or AI algorithms to the interaction of the two in order to guide learners to mastery of a domain of knowledge, or at least the crucial concepts within the domain. To a certain degree, adaptive systems research is very much about the 'how' of content sequencing, how to control content and learners, and how to adapt to changes in the learner as they move through a knowledge domain. The sequencing section of this chapter looks more at the 'why' of sequencing, why a course author would want to create a set sequence of instruction, and what the results of such sequencing are. The literature on sequencing is nowhere near as expansive as that on adaptive systems, especially from the perspective of more modern, WWW based implementations. The first of two key areas that came from the literature on sequencing looks at the 'why' of sequencing in the form of Self Regulated Learning Strategies as discussed by Young (1996), involving the concepts of learners controlling the learning process as compared to external systems, such as computer based education systems, controlling the learning process. Though the volume of content in this area was more limited, several key articles by Young and Zimmerman proved extremely valuable in solidifying the conceptual framework of this research, tying instructional theory on learning styles to the practical design and implementation issues derived from the online/e-learning and adaptive systems literature.

The second key area of research to come from the sequencing literature focussed on the current developments in applying sequencing methods to online and e-learning environments, namely the IMS Simple Sequencing (IMS SS) specification. The IMS SS specification (IMS, 2005) establishes a standardised set of rules and conditions that can be applied to learning content or learning objects within an online learning environment. Though the IMS SS sequencing model is far from simple, in terms of this research it provided two benefits. Firstly, it reaffirmed work this author had done previously when working on an earlier rule-driven learning content delivery system, as many aspects of that system were similar to that put forward in the IMS SS. Secondly, it indicated that other researchers in the field were looking at sequencing as a mechanism for the control and delivery of online learning content, without the complexity and specificity of an adaptive system model.

While the literature from the above research fields drove the how and why aspect of this research, literature regarding learner satisfaction and attitudes towards online learning environments was important in the development of the survey instruments used in this research, providing guidance as to the elements of online and e-learning that should be and could be measured from the learner perspective. Learner satisfaction is described in the literature as the amount of utility learners feel they gained from the use of an online or e-learning environment, while learner attitudes looks at the manner in which learners actually use the systems. The satisfaction literature covers interface elements, media and formats for learning content, learning content completeness and quality, course structure and system functionality to name those most relevant to this research. The research in this area indicated that as well as ensuring the system design and functionality of the CCS system was as refined as possible, the content being placed in the system would need to be of quality as well. As the discussion of research methods section of the next chapter indicates, this research was conducted 'in the field' with mature, proven learning content in order to assure the quality facet of learner satisfaction was sufficiently addressed. To this end, questions in the research instruments did not necessarily cover the quality of the learning content, but rather how it was structured, delivered and accessed. The literature on learner attitude looks less at how learners feel about a given learning environment but rather how they make use of it. Issues include how often learners log into a system, how long they use it for per session, what materials they access and what level of interaction they have with instructors and other students when online. The literature on learner attitudes looks at linkages between learner performance and learner behaviour (as in how they learn), a concept which is fundamental to this research in that possible linkage between controlling content delivery and learner attitudes is being examined.

2.1 Definitions of E-Learning, Content versus Course Delivery

The term e-learning is variably used to describe any number of different technologies and methods that can be used to deliver learning in an electronic format, predominately via the WWW (Gerhard & Mayr, 2002). Broadbent (2000) gives an apt summary of the difficulties that exist in classifying e-learning as a singular technology, stating

> "I view the moniker e-learning broadly. It represents convergence in the education, training and information fields. As I see it, the term e-learning groups together education, training and structured information delivered by computers, through the Internet, or the Web, or from the hard drive of the computer—or an organization's network. This definition of e-learning includes CBT, WBT electronic performance support systems, webcasts, listservs and other discussions on the Internet, threaded and unthreaded."

E-learning can further be defined as systems that use the WWW as a delivery medium for static learning materials, such as instructional files, or as an interface onto interactive, pedagogically driven learning environments (Psaromiligkos & Retalis, 2003). Leung (2002, p. 578) defines e-learning as "the transformation of learning: from product to process" and that which "involves cognitive processes, learning and knowledge and skill development". Lytras (2002, p. 1826) refers to the e-learning dimension which represents "the ability of an e-learning system to construct effective learning mechanisms and learning processes that support the achievement of different educational goals". Paulsen (2003) goes on to state that "E-learning could be viewed as an online descendant of computer-based training (CBT) and computer-aided instruction (CAI)". These statements are indicative of the e-learning literature, illustrating that e-learning is not simply a transposition of teaching methods and learning content from the classroom to the WWW, but rather an instructional approach that exploits elements of both. While the definitions of e-learning vary within the literature, this research distinguishes the term as that pertaining to systems and approaches that entail more than simply using the WWW as a content delivery medium.

As with the term e-learning, online learning can have a broad definition and usage according to the literature source, be it educational, academic, commercial or from the mainstream media. Whereas e-learning has been defined as content delivery integrated with an underlying instructional taxonomy, online learning is more generally categorised as "the use of a computer network to present or distribute some educational content" (Paulsen, 2003). Table 2-1 shows some of the common aspects of online learning, including system features and student activities, in this case, as classified by the University of Western Australia (UWA, 2003). Table 2-1 indicates that in this case the definition of online learning is the centralised placement of curriculum materials on the WWW, with the addition of communication and interaction tools, such as forums, chat rooms and email. Benson, Guy and Tallman (2001), when examining the transformation of traditional classroom based teaching to the online environment, states that "online education is positioned as having the best features of independent study and group-based learning, and the best features of traditional classroom instruction and distance education; thus, online education becomes more than the sum of its parts". Here again the terminology is varied, with the authors using the term online education rather than online learning, though in this case the two can be used interchangeably.

Table 2-1: Online learning features

Aspect of an online learning environment	Examples	Types of student activity
Administration - online support for learning	-Unit outline -Calendar -Notices -Class management -Assessment submission	Access to administrative resources and details through the Internet.
Communication	-Email -Discussion/bulletin boards -Chat rooms -Econferencing -Frequently Asked Questions (FAQs)	-Projects with other students (oncampus, offcampus or remote/international). -Interaction with unit coordinator/tutor. -Interaction with discipline experts from other institutions etc. -Special event contact with tutor and other students. -Online socialisation. -Information exchange.
Delivery of content	-iLectures -Handouts -PowerPoint slides	-Access to learning resources through the Internet.
Assessment	-Formative e.g., quizzes -Summative e.g., modified essay questions, assignments	-Access to feedback and self-checking resources through the Internet.
Resources	-Support material e.g., movies, images -Links to other relevant sites -Library resources e.g., journals, databases	-Access to learning resources through the Internet. -Students contributing resources and material to the website
Interactive learning activities	-Multimedia -Simulations -Computer Assisted Learning (CAL) e.g., programs that profile the learner, assesses the students knowledge and then tailors the program to the student's needs	-Interaction with learning materials. -Projects.

(UWA, 2003)

This study refers to the systems used within the online learning rather than e-learning arena, as the focus is predominately on placing learning materials and tools online in order to support classroom based teaching as well as student self-learning. The combination of online content delivery to support more traditional teaching environments and approaches is often referred to as a ‘blended’ approach (MTS, 2003). Online learning environments can fall into two main categories which describe their method of interaction with the student user, being either asynchronous or synchronous.

Asynchronous Learning Network (ALN), is a term given to a variety of online learning systems which dispense learning materials and concepts in one direction at a time (Doherty, 1998). An ALN may allow students to log in and download learning materials from a relatively generic WWW-based content delivery tool (Murugaiah, Atan, Samsudin, & Idrus, 2004) or to interact with a teaching system directly, such as working through modules that are anchored within the teaching system and are thus not downloadable. This difference in approach is often referred to in the literature as constructivist versus instructionist, with constructivist approaches allowing students to make their own pathways through environments and scenarios where they build and test knowledge, whereas instuctionsist is more defined and linear, in more of a ‘read this, now do this’ approach (Murugaiah et al., 2004; Sadler et al., 2002). According to Spencer & Hiltz (2001), the term ALNs was coined by the Sloan Foundation, which described ALN as places where people could gain access to learning materials, instructors and other students in a single place, via the WWW, though at different times and from different places (Ring, 1998). This definition is important at this point because the focus of this research and the resulting online learning environment fit firmly into the broad definition of ALN in that interaction between the system and the users is asynchronous, with students logging into and using the system independent of other students and staff members.

Synchronous online learning environments require instructors and students to be online at the same time, with instructors taking students through learning materials interactively, or moderating the live interactions between the online classmates (Chen, Kinshuck, Ko, & Lin, 2004). While synchronous learning environments are interesting, mostly cutting edge and challenging as a field of research and development, they are outside the scope of this study whose research question is firmly grounded in asynchronous modalities in regards to learning content management and delivery.

2.1.1 Managing Courses and Content

Learning Content Management Systems (LCMS) and Learning Management Systems (LMS) and are just two of the common terms used to define a class of online learning systems designed to manage, structure and deliver learning content via the WWW. Typically, the LCMS manages the actual learning content and related functions, such as storage, import and export, while the LMS controls access to the learning content, distributes learning content to authorised users and tracks user interaction with the learning content (ADLNet, 2004a; Candace, De Santo, & Vento, 2003; Paulsen, 2002). The functionality of LCMS applications is designed largely from the point of view of two classes of users, teaching staff (or instructors) and students. The teaching staff use LCMS management features to upload content into the system, arrange that content according to the needs of the course and, within the flexibility context of the particular LCMS, grant access to staff/students to some or all of the course content. Students log into the system via the LMS to gain access to their prescribed learning content, which can involve the use of interactive learning modules or simple document downloads.

Two examples of mainstream, commercially developed LCMS environments include WebCT and Blackboard, commonly referred to in the literature as Virtual Learning Environments (VLE's) (Brusilovsky & Miller, 2001; Weber & Brusilovsky, 2001), both of which are used to support training and online learning in universities, schools and commercial enterprises worldwide. The widespread adoption of systems like Blackboard and WebCT arises from the relative ease with which courses can be placed online by non-technical academic and training staff (Brusilovsky & Miller, 2001; Courtney & Patalong, 2002), whose skills exist within their own domain of expertise, and not as application developers or instructional designers (Morss, 1999). Course authors can create and control an online representation of normal class based teaching structures and practices or can add online-only facets to an existing class-based course (Courtney & Patalong, 2002; Morss, 1999; Patalong, 2003). Content within systems like WebCT can consist of almost any media type, such as a videos, audio, images, word processed documents, spreadsheets and links to other WWW materials (Brusilovsky & Miller, 2001; Johnson & Ruppert, 2002).

Other features common to systems like WebCT and Blackboard include the ability for teaching staff to create online quizzes which students can sit and be scored on immediately, as well as the logging of student interaction with the LMS, including the frequency of log-ins and log-in times, time spent on and number of accesses to specific pieces of content and of course performance on the quizzes (Johnson & Ruppert, 2002). Fernandez (2001) describes the development of the WebLearn system as a tool that allows for the rapid development and management of online courses, including banks of quiz questions, assignment management and staff/student administration through a WWW interface. Fernandez (2001, p 271), describes the goal of WebLearn to "be simple, fast efficient, robust, safe, accessible and easy to use". This goal is the ideal and vision of most, if not all LCMS and LMS developments, though each with their own specific target audience in mind.

Some LCMS's also allow for interoperability with externally authored content, such as in the case of Blackboard which allows for plug-in 'cartridges' to be integrated with an online course, such as a set of materials and tests associated with a textbook (Boggs, Shore, & Shore, 2004). Figures 2-1 and 2-2 illustrate the definition of the logical and functional differences between LCMS and LMS applications.

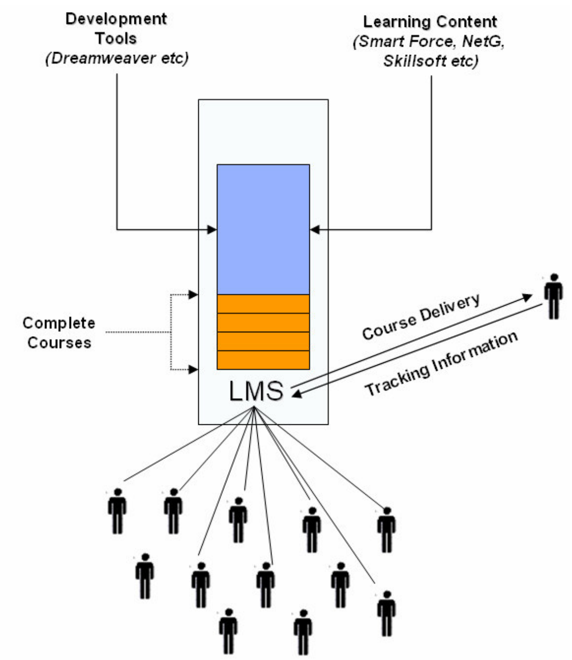


Figure 2-1: Learning Management System functions

(Nichani, 2001)

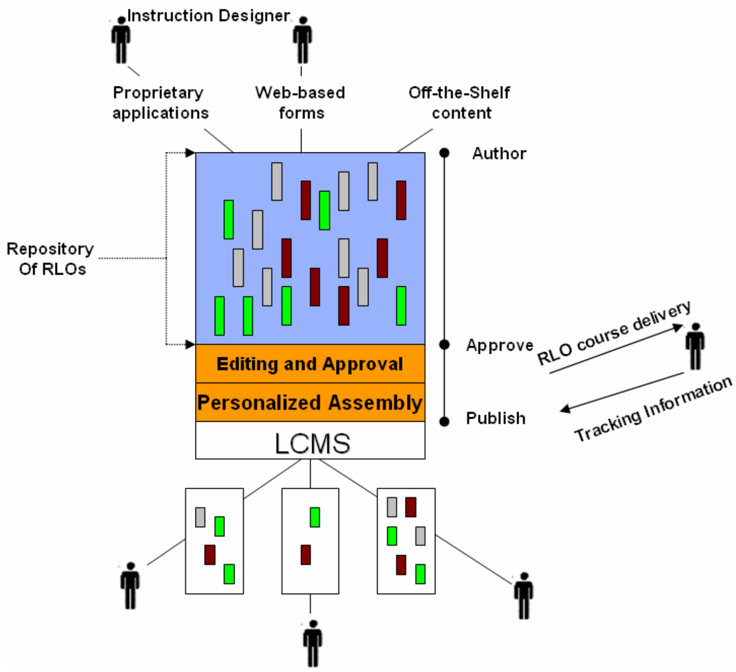


Figure 2-2: Learning Content Management System functions

(Nichani, 2001)

2.1.2 Features and Tools

While systems like Blackboard and WebCT are the commercial face of online and virtual learning environments, in-house and custom developed solutions are common, such systems being designed to meet specific teaching/training goals (as was the case of the eLCMS). The growing demand for online content delivery and management systems has driven the development of open source solutions, allowing users to implement and adapt the systems free of charge. ATutor (ATRC, 2005) is one example of an open source LCMS, being designed to provide content delivery and management services to instructors, students and course managers, with in-built support for IMS and SCORM (Shareable Content Object Reference Model) (ADLNet, 2004a, 2004b) compliant content. Given the open source nature of systems like ATutor, teaching organisations can investigate the usefulness of an LCMS environment, perhaps using such a system as a template from which to build a more complete customised solution. Universities in particular face special challenges in the design and implementation of online learning systems due to the diversity of courses, content and teaching styles (Bleek & Jackewitz, 2004). In smaller environments where face to face interaction is an important part of the teaching and learning process, synchronous environments where teaching staff and students interact online at the same time might be an optimal online learning solution. In large class environments featuring technical content requiring students to work more individually on set learning materials, an ALN solution featuring content delivery and more rudimentary, asynchronous online communication, such as forums and bulletin boards, may be better suited to that teaching/learning environment. Some of the features considered as being 'standard' in either commercial or in-house developed online learning environments include:

Chat rooms: chat rooms or live messaging facilities allow staff and students to interact online at the same time and is one example of a synchronous technology that is often incorporated into asynchronous environments. This is sometimes referred to as a blended or mixed mode (Dodero, Fernandez, & Sanz, 2003). Chat facilities are especially effective in supporting students studying in a fully online mode, as it allows them to interact with teaching staff and other students, either at a prescribed time each week, or whenever other people are shown to be online. Chat rooms also allow for online group meetings, especially relevant for students involved in group projects.

Forums: these are discussion areas, also known as bulletin boards, though usually more focussed on a particular topic or topic area. Forums allow for teaching staff to post messages relevant to a specific unit or module of teaching, and also allow staff and students to respond to messages placed on the forum by other students. Forums can be especially effective for group discussion of required topics or exploring problem-based scenarios. If the forum system is integrated with the online learning environment, such as in WebCT and Blackboard, staff can be provided with measurable evidence of student interaction.

Online Assessment Submission: this feature allows students to upload electronic versions of their assignments, such as word processed documents, spreadsheets, databases, images, audio or video files. Not only does this provide students with an easier system of assignment submission, by not having to come onto campus to submit their work, it also provides a level of non-repudiation, for both staff and students, in that an electronic audit trail exists for assignment submission and return.

Quizzes: quiz authoring tools can be built into an online learning environment or by a third party solution that can be integrated into a course system. Quizzes allow students to test and review their own learning progress whilst also allowing teaching staff to see the progress of entire classes or individual students Quiz authoring tools usually generate multiple-choice, true-false or fill in the blank style questions, allowing for instant marking and feedback for the student users. Results from these quizzes can be used simply as feedback or as a mechanism to control student progress through a course of materials. As an example, Thompson's NetG (Thomson, 2005), a system which incorporates frequent quick quizzes throughout online learning modules, though students can still choose to progress regardless of their quiz performance. Within this research quizzes are referred to as assessments, as students are actually being assessed on their learning performance, performance which dictates progress through the system.

Scheduler: this is any mechanism used to structure course content according to dates, weeks in a schedule or a series of modules to be completed. In a university environment, the schedule normally reflects the actual semester teaching schedule, usually with one week equalling a module of work to be completed on a specific topic. Content is then placed within this schedule, allowing students to see, where available, the materials and work that needs to be done and at what times.

(Anane, Crowther, Beadle, & Theodoropoulos, 2004; Chen et al., 2004; Chou, 2002; Garrison & Anderson, 2003; Lindvall, Rus, & Sinha, 2003; Lytras, Pouloudi, & Poulymenakou, 2002; Rugg, 2003; Walker & Jeurissen, 2003).

The features and tools described above are those that figured most prominently in the online learning literature, and also within the specifications of various commercial systems that support online learning. How these or other features are implemented, integrated and utilised within an online learning environment is usually a product of organisational needs versus pedagogical focus. Lytras et al (2002) argue that without intelligence and due diligence, the application and integration of the various components that constitute online learning will not actually add knowledge or performance benefit to the institution that avails itself of such systems. For these authors, an organisation cannot claim to be delivering a learning solution just by having an online learning system that delivers materials 24 hours a day. An online learning system is not really effective unless it delivers appropriate content via an instructionally sound method (in the context of the organisation in question), doing so in a manner that both motivates learners and helps them achieve their educational goals (Horton, 2002; Lytras et al., 2002).

Creating the mechanism to deliver learning materials, then populating that system with appropriate content are two key considerations in the development of any asynchronous learning environment. However knowing how students are using that content, and to what effect, is an often overlooked part of the online learning systems puzzle (Udell, 2004). The following section examines the increasing importance of recording user interaction with online systems, including learning environments, in order to identify logical and physical choke-points (problems) with the interface, content or structural facets of the system. This record of interaction is referred to as clickstream (Andersen et al., 2000; Montgomery et al., 2004) data as it allows for the tracking of user click trails, usually anonymously, through an online system.

2.1.3 Capturing Usage

Clickstream information refers to the recording of a series of clicks or interactions with an online system by one or more users. This can take the form of incidental, interpretive data drawn from WWW server log files (Padmanabhan, Zheng, & Kimbrough, 2001), or data collected by a component of a system to record specific events (Kohavi, 2001). Darbhamulla and Lawhead (2004b, p. 429) describe a "clickstream component, that continuously collects data in the background, which can be mined to get important statistical and performance information of the LMS" as part of the design framework for any well implemented online learning environment. The power of clickstream information as a tool for instructors and online course authors comes from the ability to blend student performance in such tools as online quizzes and/or pre and post test instruments to the way in which they actually utilise the learning materials within the course. Again, these authors make reference to the problem of equating student learning performance to student learning style, with performance being readily measured through quizzes and assessments. Learning style in the case of Darbhamulla and Lawhead's (2004b) research is measured by the clickstream component in their LMS framework recording all the learning resources that a student accesses during their progress through a course, and all the resources that the student decides to 'skip'. Before allowing a student to move on to a new concept, the system makes a judgement based on the quiz/assessment performances turned in by the student as well as their performance according to their learning style. The combination of performance and style dictates the student's progress in the system, either towards more advanced materials, materials at about the same level, or back into a remedial examination of previous materials.

As with the work of Darbhamulla and Lawhead's (2004b), this research collected clickstream data of student interactions with the eLCMS and CCS systems, though the CCS clickstream data was far more detailed, due to both the design and structure of the system and the requirement for detailed data for analysis. In the case of the CCS research, clickstream data was collected within the system as a record of each student's movement through the learning materials rather than being used as part of the CCS control mechanism. Similar to Darbhamulla and Lawhead's (2004b) clickstream implementation, one of the key benefits of recording each students system usage within the CCS system was that a measure was available as to how many times a student accessed a particular piece of learning content, and for how long. Knowing students used the CCS system and how they subsequently responded when surveyed about the system provided a more accurate representation of satisfaction versus attitude. Results from the data analysis chapters will show that some students believed they had a solid understanding of how they learned best, yet their CCS system usage and resulting scoring performance indicated otherwise.

2.1.4 Learning Objects, Promise and Problems

Learning objects in online learning environments refer to an individual piece of learning content that can be placed within an online learning environment, such as a VLE or LCMS and in many cases, re-used for multiple purposes (Mohan, Greer, & McCalla, 2003). Learning objects or digital learning objects can take the form of informational content, such as written materials or images, such as video sequences or animations, or even interactive objects such as simulations or quiz/testing items (Clyde, 2004; Tucker, Pigou, & Zaugg, 2002). Learning objects represent an active area of research within the online and e-learning fields, with a significant amount of work being done by organisations such as the Advanced Distributed Learning Network (ADLNet), the IMS Consortium, and the IEEE Learning Technology Standards Committee. The work of these and other organisations involves a standards-based approach to defining the conceptual and applicable role of learning objects, focussing on reuse, discovery and interoperability.

While learning objects as such were not central to this research, they are discussed here in order to clarify the context in which the terminology was used throughout this work. Learning objects in the literature of online and e-learning are often referred to as courseware, as they are components that help build the structure of an entire course of teaching/learning. In order to make a piece of learning content a learning object, descriptive or meta-data is usually applied to the object, giving a full description of the content, context and purpose of that learning item. That item can be stored in a single repository, and referenced from a central point by different courses given that the content and context of the learning object is suitable (Jegan & Eswaran, 2004; Mohan et al., 2003). The promise of the learning object comes when large numbers of objects are placed within a pool (Karampiperis & Sampson, 2005; Mohan et al., 2003) or repository. Course authors can create new courses and where the infrastructure exists, search for courseware within these pools of learning objects and slot them into their teaching/learning schedule where relevant. Conceptually, learning objects offer great utility for online learning systems development, particularly for those wishing to rapidly develop multiple courses from a centralised set of learning resources.

However, as with most technologies, learning objects are not without their problems and complexities. Clyde (2004) sees a number of problems with learning objects, some of which include the varying definitions of what learning objects actually are, and the fact that most learning objects are designed to work with particular pedagogical models. This means that a particular learning object may work with Blackboard, WebCT or other such asynchronous online learning environment, but not be relevant to a pedagogical model based upon a synchronous teaching framework. Added to the perceived lack of clarity about the true definition of a learning object is the problem of development cost, intellectual property, ability to locate such objects via a standard meta-data indexing system (Karagiannidis, Sampson, & Cardinali, 2001), and the issue of internationalisation, language and culture. Whether organisations are willing to share or sell the learning objects they have created, initially for their own use, is not certain, nor is the willingness of others to buy even if the content is available (Parrish, 2004). E-learning proponents such as the Dublin Core Metadata Initiative (DCMI) and the IEEE Learning Technology Standards Committee (LTSC) continue to work on learning object description technologies, with work progressing on the Dublin Core Metadata Element Set (DCMES) and the IEEE LTSC Learning Object Metadata (LOM) project (DCMI, 2005).

While the term learning objects is predominately used in online learning to describe the types of objects discussed above, more traditional learning resources, particularly from a university perspective, are often referred to as learning objects within the context of their use. These 'traditional' learning resources can and do include images, audio and video files, animations, hyperlinks, word processed or PDF files containing written content or lecture slides, such as Microsoft PowerPoint™ (Eklund, Garrett, Ryan, & Harvey, 1995). Certainly these types of materials are easier for academic users to develop and maintain, due to the common availability of software support tools, such as integrated productivity suites (such as office-type applications).

Before the introduction of online learning environments, such files would either be printed and distributed to students in weekly classes, or placed in a centralised location such as library from which the students could make copies. Digital media files, such as application or program files might be distributed to students within laboratory or workshop environments, with students making copies of a master disk which they would return to their instructor, or downloading the materials from a LAN. The evolution and introduction to online learning environments allows for these electronic learning resources to remain in their original digital state, placed within a central, WWW based repository that teaching staff and students can access (Bergstedt, Wiegreffe, Wittmann, & Möller, 2003). These learning resources do not necessarily represent the state of the art in pedagogical teaching/learning thinking, lacking interactivity, interoperability and even discoverability. What these resources do offer is the fact that they are an already existing teaching/learning resource, the tools for authoring content are ubiquitous and generally easy to use, they can be placed within almost any type of LCMS, and are easily transmittable and viewable to student users. By grouping various media types together within a sectionalised, domain specific structure, formerly disparate pieces of learning content can become didactically cohesive courseware modules (Grutzner et al., 2002; Psaromiligkos & Retalis, 2003). This mixture of existing electronic learning content and its delivery and management via a WWW system offers a hybrid or blended learning environment that sits between purely in-class teaching and fully interactive, interoperable WWW based learning environments (McCray, 2000).

A bulk of existing learning content, such as those found in lecture slides, readings and laboratory/workshop instruction sheets are essentially text based, a medium that offers the benefit of requiring low bandwidth, caters to many readers, allows for author control and student interpretation, is asynchronous and is easily reproduced (Collins, Neville, & Bielaczyc, 2000). The definition of learning objects and learning content referred to within this research was derived from the scope of these more basic, common learning media items discussed above.

2.1.5 Sharable Content Object Reference Model (SCORM)

The Sharable Content Object Reference Model (SCORM) is one of the few models used by online learning systems that could be considered close to a de facto ‘standard’. Research and commercial e-learning developers can use the SCORM reference model for the design of course content and course management systems (ADLNet, 2004b; Yang, Chiu, Tsai, & Wu, 2004). There are several components that comprise the SCORM reference model, from the Content Aggregation Model (CAM) which is used to describe and organise learning content, through to the Run-Time Environment (RTE) model (ADLNet, 2004a, 2004b). Effectively, SCORM seeks to separate content from control, allowing developers to use the SCORM reference model to develop one, the other or both (ADLNet, 2004a). SCORM is largely about interoperability, whereby content designed to be SCORM compliant can be ‘dropped into’ any system that supports the SCORM approach. The SCORM model allowed for the refinement of the object model in the CCS system in terms of naming conventions, and how descriptive data for a piece of learning content could be associated with the physical and structural information for that content. This is referred to in the model as the Learning Object Metadata (ADLNet, 2004a, 2004b; Farrell, Liburd, & Thomas, 2004), or data about the learning object which describes it’s design and purpose. The descriptive data associated with a piece of learning content gives information such as the title of the material, the subject of the material, and the author of the material. The structure of the learning content can describe where it fits within a structure, such as “item three within section two of topic one”. Physical characteristics such as the file type (video, audio, text, image), the file location, the file size, file access permissions and even file version can be stored against the learning content. Within the SCORM reference model examples of how these techniques can be used are found within the Content Aggregation Model (CAM) (ADLNet, 2004a). SCORM contains a lengthy list of SCORM Meta-data Application Profile Element Requirements (ADLNet, 2004a), many of which were added to those identified from the IMS SS and adapted for use in the CCS system.

2.1.6 Learning Assessment in Online Environments

In any learning environment, assessment is essential for both teachers and students alike, allowing both groups to ascertain how well the instructional materials are being utilised and absorbed. Byers (2001, p. 362) describes online assessment as

> "the collection and analysis of data through technology that permits more frequent and more convenient data collection, since technology can perform instantaneously some of the traditionally time-consuming tasks such as quiz scoring, survey application, analysis and graphic display results".

Assessment can come in many forms, but primarily online learning environments employ in-course multiple-choice, fill in the blank style quiz items and pre and post test items to ascertain student performance from the start to the completion of an online course (Byers, 2001). From a teacher or instructor point of view, assessments are devices that allow for the testing of acumen by a population of learners as to their uptake of particular learning materials. In traditional classroom based teaching, assessments are used to test students' understanding of the practical and theoretical aspects of a unit or module of teaching. By performing assessments, teachers and faculty could make decisions upon the progress of individual students through a curriculum, whilst also using the scoring results to gauge the veracity of the learning materials that form the basis of the assessments (Darbhamulla & Lawhead, 2004a; Pope, 2001; VanLehn, 1997). Debate as to best assessment practice and the real effectiveness of assessment is beyond the scope of this research. The literature on assessment focussed on the most practical types of assessments to deliver in an online environment, and the way in which such assessments could be used to guide a student through a set of online learning materials.

Alexander et al (2002) discuss the problems of assessment both in general terms, and in particular, online based assessment. A primary problem with assessment lies with students, specifically with the issue that most students in schools and universities feel that they are over assessed, that the relevance of the assessments to the learning materials is not high enough, and that changes in assessment patterns or procedures create anxiety (Alexander et al., 2002). Care must also be taken to ensure that the assessment is designed to meet the needs of the learning content, and not the reverse, where there may be a temptation to retro-fit learning content in a way that makes it more suitable for the available assessment techniques (Vrasidas, 2004). Given these concerns, the use of online assessments should be more balanced, preferably with smaller tests more regularly spaced throughout online learning materials. Not only should the frequency distribution of the assessments through the course be regular, but the assessment score weightings should be as equal as possible. Essentially, this translates to content->assessment->outcome-> with the assessment score weighting being appropriate to the content from which the assessment is derived (Alexander et al., 2002).

The selection of an appropriate assessment tool comes down to the requirement for either summative or formative assessment, the former being used to grade learners, usually into passing or failing categories, the latter, formative, being used to indicate to learners potential problems with their results, and what steps could be taken to improve their score (Iahad, Dafoulas, Kalaitzakis, & Macaulay, 2004). Summative assessment results give students a result such as their actual score out of the possible maximum score available for the assessment, allowing the student to judge their own performance. Basic summative assessments would give students a visual or written indication of which questions were answered correctly and which were not, but would not necessarily explain why. Formative assessment mechanisms would go beyond a mere score and reinforce the reasoning behind the questions that students answered correctly, and also give study hints or positive, assuring feedback on the incorrectly answered questions. The use of descriptive feedback and study hints in formative assessments are used in learner-centred pedagogical approaches, where learners are given the necessary tools to improve only their own knowledge, but their learning and research skills. Summative assessments are considered to be more of an instructor-centred tool that allows teachers/instructors to make decisions upon a learner's progress based on their right and wrong answers on a specific assessment (Iahad et al., 2004). For this study a middle ground was sought within the literature, where an appropriate mix of formative and summative assessment elements could be combined to both allow for the CCS system to make performance assertions according to a learner's score, while at the same time giving formative feedback to assist learners, regardless of good or poor performance (Buchanan, 2000).

Buchanan (2000) in his detailed look at online assessment specifies that multiple choice assessments are generally the most effective, are easy to automate and offer good performance in learner assessment in knowledge-based fields, such as computing and information science. Multiple choice tests in an online environment can be accessed by learners at a time and place convenient to them, and generally allow for a more self-paced learning approach (Buchanan, 2000). Some online learning environments such as WebCT allow time limits to be placed on how long an online assessment (quiz in the WebCT vernacular) can be accessed for before it automatically submits, or that the assessment is only available to specific users or within specific timeframes (such as certain hours on certain days).

Buchanan describes the development and usage of an online, formative assessment tool known as PsyCAL (Psychology Computer Assisted Learning), a system designed to test the effectiveness of formative assessment techniques. A facet of Buchanan's work, that had a direct impact on this study, related to the manner by which answers were provided to learners using the PsyCAL system. Where learners incorrectly answered a question, they were not given the correct answer, rather a link to further research materials that would allow them to do further research, leading eventually to a student derived correct answer. Students could then sit the same test again later, having completed their further research, in what Buchanan (2000, p. 195) refers to as the "test-learn-retest cycle which continues until the subject matter is mastered". As the methods and design section of this thesis will show, this "test-learn-retest" cycle was adapted to both a question and content section level instead of just a single question, and the cycle was altered so as not to be infinite, leading to learner abandonment of the system (Brusilovsky & Vassileva, 2003).

De Bra (2004) also adopted a formative approach in his work on adaptive hypertext systems, with learners being referred to specific chapters in a unit textbook should they answer a question incorrectly. In an interesting approach, elements of which appear in this study, De Bra did not give learners indications of which questions were answered correctly, and designed the assessments so that all 15 questions in an assessment had to be submitted together, rather than one at a time as some systems require. De Bra's reasoning was that this approach reduces the likelihood of learners guessing the answers, whereby learners would fill in any answers without really looking at the questions, submit the assessment, after which they would be presented with the correct answers. This approach also features in this research study, and influenced the construction of the assessment items used in the CCS. Finally, De Bra also raises an issue that features as a prime research focus for this study, from a usage and attitude point of view, regarding the manner in which learners approach studying for an online assessment. De Bra found that aside from the recorded 40% incidence of cheating (Pathak & Brusilovsky, 2002) in his target population (perpetrated by viewing source code or getting friends to provide answers), that "students started from the quiz, and searched through the course text for information to get more and more correct answers, instead of reading the complete text before making the first attempt at the multiple-choice test".

Pathak & Brusilovsky (2002) looked at the issue of online assessment, in this case within the confines of a programming course, from the point of view of student self assessment, finding that "48% of respondents thought that it 'can significantly help', 37%

thought that it ‘can help’, 15% thought that it ‘can sometimes be of help’ and none found them useless” (p. 1552). Though the system in question, QuizPACK, was more advanced than the types of assessment items used in this research, the evaluation of the assessment systems is what is of most interest. It would appear that online assessments are indeed popular with students as tools for self-assessment, and in particular, assessment based on individual sections of learning content throughout a course, not just certain sections of the course (Pathak & Brusilovsky, 2002). Finally, Schank (2002, p. 253) notes that “Students vie for grades and refuse to learn something if it won’t be on the test”. While this can be construed as a somewhat cynical point of view on Schank’s behalf, it is likely to be an accurate reflection of the attitudes of some in not many teaching staff in universities and other learning institutions around the world. If Schank is correct, then the introduction of frequent quizzes/assessments that control progress through a series of learning materials may hold at least part of the key to getting students involved in their own learning processes.

2.2 Modelling the Learner and the Content

As discussed at the beginning of this chapter, there is a considerable base of literature and research in the area of adaptive systems, systems that are designed to change dynamically in response to user performance and choices (Brusilovsky & Vassileva, 2003; Eklund & Brusilovsky, 1998; Karampiperis & Sampson, 2005). The two primary areas of literature involving adaptive systems come from WWW based adaptive systems and adaptive hypermedia systems. Adaptive systems as they currently appear in the literature have their origins in both the fields of Adaptive Hypermedia (AH) and Intelligent Tutoring Systems (ITS), aspects of these areas now finding new life in the WWW environment (Brusilovsky, 1999). Though the focus of adaptive systems is based more on reacting to the user and adjusting their course and content level dynamically rather than necessarily controlling the set sequence of a course, adaptive technologies provide an excellent starting point from which to build any type of learning environment that features user-specific sequencing. It is from this literature that many of the implementation and design elements of the CCS were drawn, including a refinement of the underlying object storage model, the multa-section structure and the use of assessments as decisions points for controlling student progress through the system.

The literature on adaptive systems shows that by modelling the learner, human tutor and the knowledge domain of instructional content, powerful pedagogical outcomes can be obtained (Ong & Ramachandran, 2000). The literature also shows that though powerful, these adaptive systems are not necessarily quick and easy to configure (Ardito et al., 2004), are usually task-specific and require significant investments in content and system development (Ainsworth & Grimshaw, 2002). Figure 2-3 shows a diagrammatic summary of the principal types of adaptive systems and their functions identified within the literature, including the Adaptive Instruction Model, Adaptive Learning Environment and the Intelligent Tutoring System.

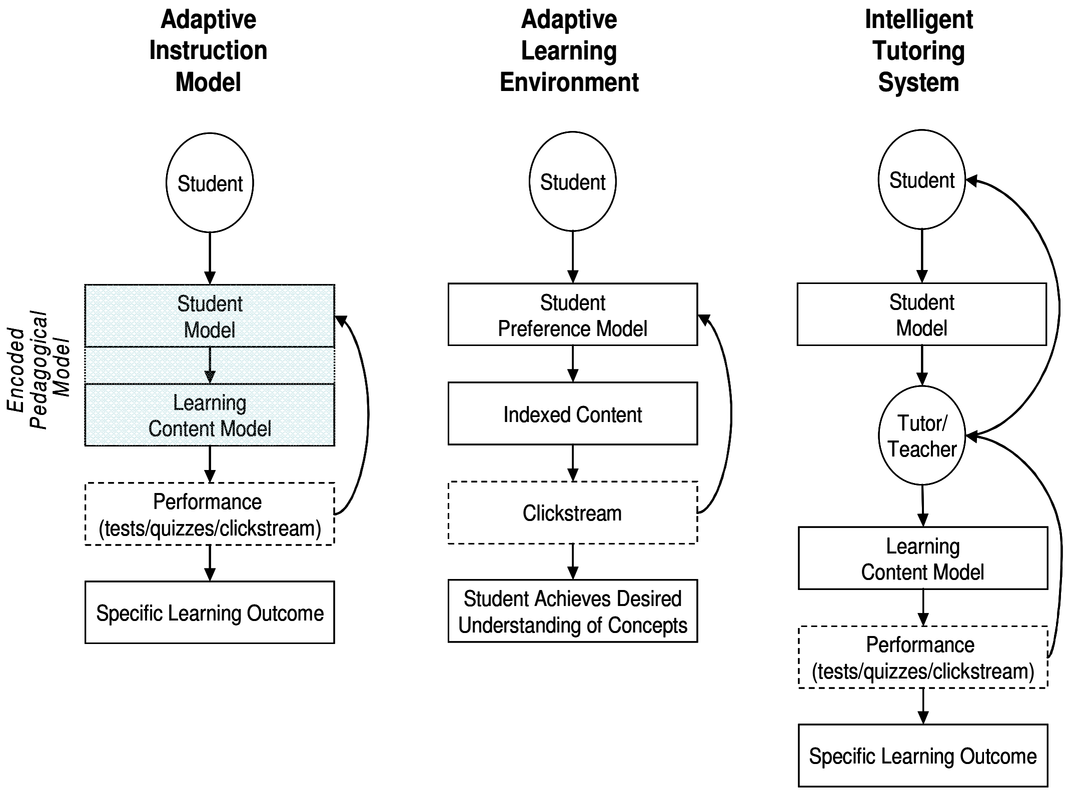


Figure 2-3: adaptive system approaches

The Adaptive Instruction Model defines the concept of a system whereby student interactions with the learning materials, measured against their test/quiz performance (Sison & Shimura, 1998) and/or their navigational path through the materials (eg do they skip content along the way?) (Darbhamulla & Lawhead, 2004b) evolves the student model in an ongoing manner. The student model is designed to store the current position of the student within the knowledge domain of the course, and where possible gaps/weaknesses exist in their knowledge. This information drives the learning content model, whereby learning materials relevant to the student's perceived level of conceptual understanding are presented to the student, in either a mandatory or optional manner depending upon the encoded pedagogical model. It is this pedagogical model (Baldoni et al., 2002) which is used to gauge at what point the student model would indicate that the student has achieved a specified level of topic mastery, and at which point the learning outcomes for the student within the course can be deemed as being complete. Adaptive systems using this type of model are usually driven by a combination of the underlying pedagogical model and the student learner (Helic, Maurer, & Scerbakov, 2004), allowing the learner some independence and choice within the learning environment on their path to achieving the specific learning outcomes.

Whereas modern adaptive systems are designed to allow new content to be added and integrated into the adaptive model, and in many cases to be used as a complement to existing teaching structures (such as class-based instruction), intelligent tutoring systems were initially designed as human teacher analogs with which students could interact. While modern adaptive systems are designed to be multi-modal, allowing the adaptive engine to encode and deliver different content on different topics, intelligent tutoring systems were usually designed to thoroughly immerse a student within a specific knowledge domain, such as training and competency building in technical fields. The tutoring/coaching system was essentially an expert system that had been encoded with an 'understanding' of the knowledge domain contained within the system, as well as problem solutions to the tasks that students were asked to perform. By using the expert system, the learning materials content model and the changing state of the student model, the tutoring system could make recommendations, offer advice and take students through remedial materials, again, depending upon the performance of the student. As Figure 2-3 indicates, the student would interact with the tutoring system, which in turn would control the student's course progress through adapting the student/tutor dialog and the level/sequence of learning materials. Intelligent Tutoring Systems are discussed further in section 2.2.2.

The Adaptive Learning Environment provides a conceptual representation of adaptive systems, particularly those with hypermedia origins, which are more exploratory in nature, allowing students to define their own pathway through a domain of knowledge or content. In this type of adaptive model, the student model is not used to gauge performance or topic mastery but rather to continuously examine a student's preference (or profile) (Chalamish & Kraus, 2002) according to the links they follow and the media they spend time interacting with (represented in the diagram as the clickstream). The adaptive system in this example would be designed to present the student with more content along the same topic as they had been exploring, usually by adapting the navigational interface using a method Brusilovsky (2000a) defines as "adaptive navigation support", by having a dynamically changing set of 'suggested links' or back/next navigation links, or via a combination of both these methods (Wu & De Bra, 2001). As well as indexing the content by topic in order to gauge the material's relevance to the students evolving clickstream, content could also have assigned 'levels', such as on a concept difficulty scale, for example 'easy', 'medium' or 'hard'. The further the student delved into a topic, the higher the content difficulty would go until all content had been exhausted or the student changed their clickstream pattern, possibly indicating that the content difficulty had become too high. Adaptive systems of this type would be used primarily as an aid to student comprehension of a topic rather than as a mandatory part of a curriculum, due to the exploratory and more fully student-driven adaptation.

2.2.1 Student Modelling

Adaptive systems are designed to meet the diverse needs of users who come into a learning environment with different levels of competencies and backgrounds (Heift & Nicholson, 2001). The primary goal of adaptive systems is to create accurate, dynamically changing models of individual learners, these models being used as representations of how learners are progressing within the content domain of the course (Conati & VanLehn, 2001; Miskelly, 1998). Adaptive systems tend to a more Socratic (Du Boulay & Luckin, 2001) approach to interaction with learners, with the intelligence built into the adaptive system being used to decide the type and level of content that a learner should be presented with according to how they are currently performing within the system, leading to a more tailored, learner-centred experience (Arruarte, Fernandez-

Castro, Ferrero, & Greer, 1997; Shang, Shi, & Chen, 2001; Sison & Shimura, 1998; Whitehurst, Powell, & Izatt, 1998).

Tang and McCalla (2003) use the example of the Paper Recommender system that was designed to make recommendations to students about what conference or journal papers to read, based on their level or experience and expertise. As the authors indicate, a recommender system would not be very useful if it repeatedly recommended papers to learners who found the content of those papers either too easy or too difficult to comprehend. The authors used three techniques to build a model of the learners in their system: questionnaires, assessment active and assessment passive. Questionnaires are used to directly ask learners what type of papers they prefer, such as journal or conference, what type of depth they prefer, such as shallow or in-depth. Assessments test students on the content of the papers to see if they have actually absorbed some of the knowledge contained within the papers, while the passive assessment (essentially a clickstream mechanism) examines how the learners work with the paper, such as how often they accessed the materials and in what order. The active assessment techniques allow initial learner models to be delivered, with the testing and passive techniques allowing for a refined and a more accurate model, a process referred to as knowledge/model tracing (Corbett & Anderson, 2001; Tang & McCalla, 2003). Most student modelling systems follow a similar procedure, in which a starting point or reference template for a learner is created by the system so that the expertise or intelligence encoded into the system can adapt the course structure and content to the individual learner (Angehrn, Nabeth, & Roda, 2001; Blessing, 1997; Papanikolaou, Grigoriadou, Kornilakis, & Magoulas, 2003).

The difficulty in designing an effective learner modelling system comes from the requirement of not only gauging what the learner already knows, but how the learner actually learns (Eklund & Brusilovsky, 1998; Papanikolaou et al., 2003). Another complexity in the field of student modelling is linked to the modelling of a domain of knowledge, in that a truly adaptive, reactive system needs to understand the way in which the learner works best, and at the same time have an understanding of the learning materials so that the most effective materials are presented to the learner at the right time in the right sequence. This translates into a requirement for a system to be able to assist a user to explore a problem domain, while at the same time that system must also understand the problem and processes that are required for the problem solution (Brusilovsky, 1994a, 1994b; Melis et al., 2001; Papanikolaou et al., 2003).

In the case of this research, the student and domain model did not require the complexity of those found in adaptive systems, yet some of the underlying principles of these student and domain modelling techniques proved to be extremely useful, especially in the area of learner tracking. At the heart of most adaptive systems that feature learner and domain modelling is a series of complex data repositories that map highly specific values about performance and completion (for the learner) against learning materials (the items the learner interacts with). When discussing various methods of constructing and updating student models, Brusilovsky (1994a, p.73) refers to a model that is "directly updated as a result of a student action". It is this type of model which was adopted for this research, combined with a state-based object model that represented the current state of every learning object within the course, mapped against each learner in the system (De Bra, Aerts, Smits, & Stash, 2002). The reason for the adoption of this model is mostly technical, in that hyperlinks, which formed the navigation interface of the CCS system, can be used to fire the back-end scripts which communicate with the system database, thus allowing all events to be recorded, and the student's course completion model to be updated accordingly, on a per-click basis. In the case of this research, the "student action" is recorded as and driven by click events on the links to learning materials within the CCS system, including the submission of section based assessments. Essentially, as a user was added to the system, the relevant score, number of attempts and completion values (properties) of all the learning materials within the course were automatically mapped against the object that was the learner, with all values set to their defaults (ADLNet, 2004a; Ceri, Dolog, Matera, & Nejdl, 2004; De Bra, Houben, & Wu, 1999;

Ignizio, 1991; Rumbaugh, Blaha, Premerlani, Eddy, & Lorensen, 1991; Whitehurst et al., 1998).

2.2.2 Intelligent Tutoring Systems

Intelligent Tutoring Systems (ITSs) were among the first advanced computer based instructional tools designed to encode teaching and learning intelligence into a digital form. Intelligent tutoring systems were generally designed with very specific educational outcomes in mind, with the systems being designed to perform as their name claimed, to be tutors to learners (Angelides & Paul, 1993; Virvou & Moundridou, 2001). An early example of an ITS capable of embedding knowledge with a digital repository are the Sherlock I and Sherlock II tutoring programs. Developed by Alan Lesgold. Sherlock II was designed as a coached apprenticeship system to impart and test electronic troubleshooting skills to U.S. Air Force electronics trainees. Sherlock II gave a computer based representation of an actual systems-testing device used to analyse circuit pathways within F15 fighter aircraft. The purpose of Sherlock II was to present simulated error situations to avionics trainees, requiring the trainee to decide the most likely procedure to locate the fault. This was done by creating a multimedia representation of the actual testing device, using graphics, text and audio for the visual interface. Trainees were presented with a simulated fault by Sherlock II, and were required to track the fault and provide a logical reason for the fault occurrence. Sherlock II encoded the domain knowledge of the real-world testing unit, down to the actual tasks that each switch and dial performed, using an in-built expert system and fuzzy probability distributions (Gabrys, Weiner, & Lesgold, 1993; Katz, Lesgold, Eggan, & Gordin, 1993; Miskelly, 1998; Ong & Ramachandran, 2000).

Ong and Ramachandran (2000) give an excellent overview of intelligent tutoring systems, particularly when noting Bloom's "two-sigma" problem, whereby learners that received one-on-one human tuition usually performed two standard deviations better than those that did not. Bloom (1984) believed that the goal of any pedagogical construct should be to deliver teaching to a large group of learners at the same quality and level of effectiveness as found in one on one tuition. Statistics from Lesgold's Sherlock II system, indicate that trainees who conducted 20 hours of tuition with the Sherlock II system were performing as well as those qualified technicians who had fours years hands-on experience (Ong & Ramachandran, 2000).

> "The goal of ITS is to provide the benefits of one-on-one instruction automatically and cost effectively. Like training simulations, ITS enables participants to practice their skills by carrying out tasks within highly interactive learning environments. However, ITS goes beyond training simulations by answering user questions and providing individualized guidance. Unlike other computer-based training technologies, ITS systems assess each learner's actions within these interactive environments and develop a model of their knowledge, skills, and expertise. Based on the learner model, ITSs tailor instructional strategies, in terms of both the content and style, and provide explanations, hints, examples, demonstrations, and practice problems as needed". (Ong & Ramachandran, 2000)

ITS applications are effective in that they offer one-on-one tutoring with learners, simulating a human tutor, without ever growing impatient, tired or under pressure from other students (Murray, 1999). ITSs, properly encoded with the necessary expert domain and pedagogical knowledge can guide, reinforce, assure and correct learners, at a pace set by the learner (Butz, Hua, & Maguire, 2004). Just as a human tutor tries to adjust their style on an individual basis for each student where possible, so ITS's dynamically adapt new pathways and sequences through domains of learning content, best suited to the individual user (Perez, Gamboa, & Ibarra, 2004). The lessons learned from ITS in relation to this research come from the use of assessments, content and course sequencing and the use of feedback, both positive and negative. While the learning model within this research is of a more linear approach with a minimum of dynamic adaptation (in the sense of creating new pathways through domain knowledge), the initial concepts of assessments, content control and sequencing originated in the review of the ITS literature.

2.2.3 Adaptive Hypermedia Systems

While the literature on intelligent tutoring systems introduces the concepts of encoding expert knowledge into a computer based teaching and tutoring system, usually with specific learning outcomes as the goal, Adaptive Hypermedia systems (AH) are systems that act as guides through a non-sequential hyperspace of learning content and navigational links (Eklund & Zeiliger, 1996). AH systems are more exploratory and learner driven as opposed to instructional and outcome driven, such as with ITS type learning environments (Eklund, 1995; Eklund & Zeiliger, 1996). In traditional hypermedia systems, a set domain of links to content is presented to the learner, which they can follow in either a linear or non-linear fashion, working through an electronic or online encyclopaedia, which can have linear pages of content nested within specific subject areas, nodes or pages (Brusilovsky, 1996) as they are often referred to in hypermedia systems. Every user of such a system would see the same links on the same pages to the same content, regardless of how many times they used the system and what their specific interests were. In an adaptive hypermedia version of the same encyclopaedia, each user would start seeing different links to different content according to the nodes (subject areas) they were most frequently viewing and re-visiting. For example, should a user start browsing content on space exploration or spacecraft, the system would begin to adapt to their viewing and navigation patterns, presenting them with content related to space exploration, spacecraft, astronomy, aeronautics. The more a user interacts with a system, the more accurately the system can adapt to that individual user's interests and navigational style (Brusilovsky, 1999, 2003; De Bra, 2004; Eklund & Zeiliger, 1996; Triantafillou, Pomportsis, & Demetriadis, 2003).

AH research came from the perceived problem in some traditional hypermedia systems that learners could become lost or disoriented within large systems, especially as the exploratory nature of the systems can lead to learners moving away from their initial learning paths on tangents (Eklund & Zeiliger, 1996; Henze & Nejdl, 2001; Triantafillou et al., 2003). Using another analogy, one could imagine that a traditional hypermedia system is akin to a learner doing research in a library, using the library catalogue and subject headings as a guide to where to search for particular items in the library. In an adaptive hypermedia system, the same learner would have access to the same catalogue and subject headings, but would also be accompanied by a librarian, who would be constantly examining the items that the learner is interested in, making suggestions on further readings in the area (De Bra, Houben et al., 1999). In advanced AH systems, not only would the hypothetical librarian be able to suggest further readings to the learner, they would also be able to judge the learner's level of field expertise and cognitive level, making suggestions in regards to content that the learner could most effectively absorb and understand (Brusilovsky, 1996; Henze & Nejdl, 2001; Melis et al., 2001; Tang & McCalla, 2003; Triantafillou et al., 2003).

2.2.3.1 Dexter Hypermedia Reference Model

The Dexter hypermedia reference model was an attempt by researchers in the late 1980's and early 1990's to bring together the various functional and logical elements of what was considered to be the state of the art in hypermedia systems (De Bra, Houben et al., 1999; Gronbaek & Trigg, 1996; Halasz & Schwartz, 1994). Another aim of the Dexter model was to standardise the terminology used in conjunction with hypermedia systems, particularly terms such as 'nodes', as each author and developer used the term within the context of their own research and systems (De Bra, Houben et al., 1999; Halasz & Schwartz, 1994). It could be said that the same problem exists today in the field of e-learning and its subsequent proliferation of terms that are used interchangeably in the literature, but often in completely different contexts, an issue raised in the earlier discussion of learning objects (Clyde, 2004). The Dexter reference model provided a template from which hypermedia systems, and eventually adaptive hypermedia systems, could be built throughout the 90's, and even though today some elements of the model have started to look dated, the fundamental building blocks of content storage and linkage are still strong.

In the case of this research project, the Dexter reference model was invaluable in resolving issues of storing representations of different components of the CCS system, such as sections, learning content (or learning objects), assessments and students. Everything that was stored in the CCS was defined as an object, with a unique object identifier, based on the Dexter model's Unique Identifier (UID), while each object in turn was described by a large number of individual database records which were stored separately to the objects. These individual records, or attributes, were linked to the objects using unique attribute identifiers, similar to Dexter's Anchor Id functions. As Dexter used its storage layer to represent the atomic units (such as text, images, video documents) that, when combined, created components to be integrated into a hypermedia system, the CCS system had a Week object (of teaching content) comprised of Sections, each Section being comprised of Lecture, Reading, Workshop and Assessment objects (Halasz & Schwartz, 1994). Each object was in turn fully described by a list of attributes, each of which had a number of properties, or potential values (Brown, 2002). Dexter also contributed to the design of these attribute/value pairs which when combined, fully described and specified any object within the CCS. Primarily, the storage layer functions (De Bra, Houben et al., 1999; Halasz & Schwartz, 1994) from Dexter, such as AttributeValue and LinksTo were integrated into the CCS storage model, though the LinksTo function was adapted to a slightly different function called WithinObject, which was stored as an attribute of an object, with the value of the WithinObject attribute being the UID of the parent object. In this way, objects can 'read-up' to see where they belong in a structure, while at the same time they can also 'read-down' to see what other objects they contain, all depending upon the context of the object with the course structure.

2.2.3.2 Adaptive Hypermedia Application Model

The Dexter model is taken further in the development of the Adaptive Hypermedia Application Model (AHAM) (De Bra et al., 2002; De Bra, Houben et al., 1999; Wu, 2000) which adds the adaptive functionality to the original Dexter. The work on AHAM focuses on rules overlayed on the storage model introduced by Dexter, these rules being used to model a user, in terms of the content they have learned, and what they are yet to learn (De Bra, Houben et al., 1999). By modelling the student user and the content domain, the AHAM aims to organise and control content, which in the case of AHAM is achieved by removing, disabling, hiding, sorting or annotating links to the learning content (De Bra, Houben et al., 1999). By controlling access to the links within a hypermedia system, access to the content at the end of those links is controlled, these methods being referred to by Brusilovsky (1996) as adaptive presentation and adaptive navigation. Adaptive presentation is where the content of a page or node is controlled by the system according to a set of rules, usually as the result of the current student model, whilst adaptive navigation controls how, and if, the actual node/page is accessible. In the context of this research these elements were combined with the Dexter inspired storage model for the structure, content and learners within the CCS system. The result, as will be shown in later chapters, is a navigation system within the CCS that controls user access to available content, based on the progress of the learner within the pre-defined course.

While not ‘adaptive’ in the same way as the systems discussed here, the CCS methodology is driven by the literature and example systems that use a combination of link and content control to guide learners through a content domain. The logic engine driving the CCS is derived in part from what Brusilovsky (1996, p.15) describes as ‘conditional text’ or a system whereby

> “Each chunk is associated with a condition on the level of user knowledge represented in the user model. When presenting the information about the concept, the system presents only the chunks where the condition is true. This technique is a low-level technique - it requires some "programming" work from the author to set all the required conditions - but it is also very flexible. By choosing appropriate conditions on the knowledge level of the current concept and related concepts represented in the user model, the author can implement all the methods of adaptation listed above excluding sorting. A simple example is hiding chunks with irrelevant explanations if the user's knowledge level of the current concept is good enough, or turning on a chunk with comparative explanations if the corresponding related concept is already known.”.

The concept of breaking content into ‘chunks’ and then controlling access to that content played a significant role in the development of the CCS structure, and how access to that structure could be used. Whilst Brusilovksy refers to the knowledge level of the current content versus the knowledge level represented within the user model, a simplified version of this concept was implemented within the CCS link and content control system. Each piece of content had specific scores associated with it (presented in the form of assessments), the sections (or nodes) had specific passing criteria tested by conditions based on the combined content scores, processed via rules of progression according to the score and number of attempts for these items stored against each student with the storage model.

2.2.3.3 KMS Hypermedia Model

The KMS hypermedia system was another that offered a useful reference point when refining the storage model for the CCS, with its use of frames as containers for content (Akscyn, Yode, & McCracken, 1988). Frames are both logical containers in which content can reside, similar to components in Dexter, except that the frame specifies the visual presentation as well as the logical, database level storage. Different individual files such as images, text, videos and animations can be placed within a frame as long as they actually fit within the visual confines of the screen-sized frame (Akscyn, McCracken, & Yoder, 1988). While KMS was originally designed to run on specific hardware and operating system platforms, thus the requirement for a set maximum screen size in which to place frames and their contents, the concept of the frame acting as a container for different, editable pieces of content assisted in the development of the aforementioned CCS object/attribute based storage model. Like Dexter, KMS allowed for frames and their contents to be linked to other frames, once again a concept that was integrated into the CCS to allow objects to be linked, in this case as parent to child or child to parent links.

While the visual interface and data model of the KMS system was highly interleaved (Akscyn, McCracken et al., 1988; Akscyn, Yode et al., 1988), in the WWW-centred CCS system the interface was separated to a large degree from the data model, though it was driven by the contents of the data storage system, dependent upon each learner and their progress through the course materials and objects (Schwabe & Rossi, 1998). Ignizio (1991, p. 71) gives an excellent description of frames (as originally developed by Minsky, Schank and Abelson) from an expert systems point of view, describing a frame as something that "contains an object plus slots for any and all information related to the object". In the case of the CCS system, these slots are attribute names and their values, linked to the parent objects. Ignizio also indicates that while frames are extremely robust as an object representation and storage method, due to the highly flexible and extensible nature of data framing, usage in real-world applications can be quite complex, and is usually confined to expert-system implementations.

This assertion by Ignizio proved extremely accurate, in that the CCS system relied totally on the use of a frames-based model and the subsequent amount of programmatic and data access complexity introduced by the use of frames was far greater than initially expected. These issues are primarily cited as this study was based on a systems development method / heterogeneous field study (addressed in Chapter 3), where both the research and technical features of the CCS went through a number of development cycles before the final system was arrived at.

2.2.3.4 Object Oriented Hypermedia Design Method

The Object Oriented Hypermedia Design Method (OOHDM) (Schwabe & Rossi, 1998) allows authors of hypermedia systems to understand the relationships between navigational design, interface design, conceptual design and implementation (Schwabe & Rossi, 1998; Schwabe, Rossi, Esmeraldo, & Lynardet, 2001). The conceptual design elements of the OOHDM were used to reinforce the concepts drawn from KMS, Dexter and the AHAM, essentially as these system used similar underlying conceptual models to describe how objects could be comprised of smaller objects, referred to in the OOHDM as Entity Objects (Schwabe & Rossi, 1998; Schwabe et al., 2001). While the OOHDM does not necessarily go into specific detail on how to map conceptual and navigation objects into nuts and bolts data items within a database system, (Schwabe & Rossi, 1998) does state that "since the majority of DBMSs available on the market today are relational, a mapping of the OO models onto equivalent relational models must be made". This mapping was carried out in the case of the CCS system using the principles discussed in the OOHDM, Dexter and KMS, with contributions from the application development literature regarding more mainstream OO methods (Chung, Shih, Huang, Wang, & Kuo, 1995; Q. Li & Lochovsky, 1998; Rumbaugh et al., 1991). These methodologies and approaches to systems development and implementation were addressed to ensure that any approach that could potentially benefit the CCS system from a technical standpoint were identified and integrated into the final system.

2.2.4 WWW Based Adaptive Systems

As well as the LCMS and VLE based online learning environments discussed earlier in this chapter, a large number of systems now exist, in research and commercial forms, that integrate the features of earlier adaptive systems into current WWW based education environments (Weber & Brusilovsky, 2001). While in-house developed online learning environments and commercial VLE's have proven to be extremely popular within university and other educational environments due to their inherent flexibility and ease of use, the same cannot be said for adaptive systems currently evolving in the WWW context (Weber & Brusilovsky, 2001). In the way that personal computer systems in the 1970's were the domain of experimenters who built systems to suit their own requirements, so today are a majority of adaptive, WWW based systems.

2.2.4.1 The ELM-ART System

The ELM-ART system was a development platform based on Adaptive Intelligent Web Based Education Systems (AIWBES) research (Brusilovsky, Schwarz, & Weber, 1996; Weber & Brusilovsky, 2001). ELM-ART started life as a platform dependent expert tutor known as ELM-PE, used in the teaching of LISP programming. As the system developed and the decision was made to transfer the functionality to the WWW platform, the encoded contents of the system had to be translated to into WWW compatible formats, such as HTML. Content was divided into small subsections, or 'chunks' as they have been referred to, each piece of content within each subsection being relevant to a specific concept to be taught (Brusilovsky, 1994b; Brusilovsky et al., 1996).

As with other adaptive systems, ELM-ART was designed to record student levels of understanding, or completeness, of various concepts encoded into the system. As the ELM-ART system evolved, assessments and tests were add as mechanisms to more accurately gauge student knowledge of the concepts being taught and allow the adoption model to present content to the learners that best suited their requirements (Brusilovsky et al., 1996; Weber & Brusilovsky, 2001). The ELM-ART system as described by Weber and Brusilovsky (2001) offered a wealth of concepts from which to draw in the development, implementation and focus of the CCS system. What immediately became apparent from the descriptions and visual representations of the ELM-ART system is the use of learner models that show learners what they have completed, what they are yet to complete, and the structure and type of content that is available (Clark & Mayer, 2003). While many of these elements were integrated in some form in the final CCS system, a primary divergence that was immediately obvious when researching the ELM-ART system is that the CCS would control the sequence of course content based on frequent student assessments based on the specific content the learners were being presented with (Brusilovsky, 2000b). While the ELM-ART system was designed more in the context of both the formal representation and assessment of knowledge mixed with learner exploration of the knowledge domain encoded into the system, the CCS system was always intended as a focussed present-review-proceed environment using linear, set content pathways (Brooks, 1997; Clark & Mayer, 2003; Horton, 2000, 2002). While the primary function of the CCS system was not to create another adaptive, learner-driven online learning environment, the system owed a large amount of its design to the research conducted in the ELM-ART system.

2.3 Course and Content Sequencing Techniques

The literature examined so far has looked at both online learning environments that manage and gives access to the learning materials as well as the more complex systems that aim to adapt to the pedagogical and exploratory needs of the learners using them. From the literature on adaptive systems the concept of how content within an online learning environment could be controlled and sequenced was discussed, and though the context of that sequencing is different in those systems than in this research, many of the principles and methods apply, such as student modelling and the use of regular quizzes/assessments (Alexander et al., 2002; Brusilovsky, 1994a, 1994b, 1999, 2003; Brusilovsky et al., 1996; Buchanan, 2000; De Bra, 2004). The use of course and content sequencing in any online learning environment can be as much a product of a specific teaching strategy used by an instructor as it is a research mechanism for evolving new, learner-centred pedagogical techniques (Fischer, 2001; Schank, 2002). The recent development of content and course sequencing models, such as the IMS Simple Sequencing (IMS, 2003a) model, for integration into online learning environments, indicates that sequencing of online learning materials may indeed be desirable, and being examined by organisations such as the IMS and ADLNet. Given that these organisations are currently driving 'standards' work on online learning content and course models, their investigations into more mainstream rather than researcher driven sequencing systems indicates that sequencing may become a common feature or add-on to existing commercial LCMS and LMS systems.

Within the context of this research sequencing refers to the linear presentation of learning materials, interleaved with assessments as sequencing control mechanisms, in order to reinforce content contained within learning materials. Wescourt, Beard and Gould (1977, p. 236), looking at approaches for aiding in student comprehension and task performance, state that "in considering alternative representations for the knowledge underlying a task, we recognized that the most powerful approach would be a procedural representation sufficient to synthesize task solutions". While these authors examined the benefits of procedural, step-by-step processes by which students could learn programming techniques, this research study examined the procedural analog of presenting step-by-step theoretical (lectures and readings) and practical (workshops) knowledge. From the literature on ITS and adaptive systems discussed so far, further research on sequencing can be categorized into two areas, those being the why and how of sequencing, both of which are examined in the following two sections.

2.3.1 Simple Sequencing

The evolution of the sequencing model used in the CCS system can be traced through the literature and this researcher's own earlier work. This work was primarily in the area of object oriented data models and rule-based expert systems for the purpose of developing a reliable data storage object model as the basis of an extensible, rule-driven LMS (Brown, 2002). The original system from which the CCS was derived focussed on encoding data about learning objects, student models and rule events, conditions and actions (ECA) in an extensible system that would allow course authors to create rules which would trigger actions based an multiple event conditions (Brown, 2003).

For the purposes of this research the object and rule model was simplified to the current CCS control structure, with the rule elements removed from the storage layer and placed within the application layer. While the initial concepts for the CCS were still under development, a model for content sequencing was released by the IMS Global Learning Consortium (IMS, 2005). The IMS Simple Sequencing Specification presented a very detailed set of guidelines for designing an object model for content description (via metadata) as well as rule elements for controlling content based on content state (Abdullah & Davis, 2003; IMS, 2003b). The term simple sequencing in the name of the specification is somewhat of a misnomer as the complete specifications for IMS SS are complicated, repetitive and work on the assumption that the target audience is fully conversant in the field of LMS and CBI development (LSAL, 2005). IMS Simple Sequencing was designed as a specification that would allow developers of online learning systems to specify activities and objectives that needed to be met in order for a learner to proceed through a tree-structured content model (IMS, 2003a, 2003b, 2005;

Yang et al., 2004). The IMS sequencing specification was added to the Sharable Content Object Reference Model (SCORM) upon release of the SCORM 2004 specification, allowing for sequencing and navigation to be applied to SCORM compliant content. While a number of the functional elements of the IMS SS specification had been implemented in different forms by this researcher previous to the release of the specification, what was of most interest and value to this current research was the list of Elements and Attributes (IMS, 2003a) laid out in the IMS SS to describe both the content that was being controlled by the sequencing as well as the functions of the rules that would be controlling that content.

These element and attribute values were translated into a context relevant to the CCS system, and were used initially as part of an IMS / SCORM style naming convention, though some of the function meanings from the IMS SS elements and attributes were used similarly in the CCS system. As IMS SS uses Objectives within a node structure to decide if the resources within the node are completed to a level where the node itself can be designated as complete, so the CCS system uses a similar method to control the 'states' of objects within the structure. As an example, in the CCS structure, the top level node (in the case of this research) is a week of learning materials, in this case, Week 3. Three sub-nodes that represent the three sections of the weekly learning content and within these three sections resides the learning content objects and associated assessment items. When all of the learning content objects within a section have their Complete attributes set, and the total assessment scores for that section equal or exceed that specified as the section PassingScore, then the Complete attribute for the given section is set. The rule-set encoded into the CCS system identifies that a change or transition (Eklund & Brusilovsky, 1998; Gagne & Trudel, 1996) has occurred and makes the appropriate change in state to the student model, in this example, toggling the Available attribute on the following section of content from zero to one, after which the first content item in that section also experiences a state change in the Available attribute from zero to one. Once all three sections (or however many are within a given week of content) have had their Completed attributes set to one, the Completed attribute for the given week is then changed from zero to one. During a student's progress through the system, the rule-set constantly examines how many of the sections within a given week have their Completed attributes set to 1, very much like the selectCount element in IMS SS. Once the rule-set identifies that the number of Completed attributes against the section nodes equalling 1 within a week of content matches the number of sections defined within the week, somewhat like the IMS SS minimumCount element, the state of the Completed attribute for the week is set to one.

As SCORM is indeed a reference model and, according to its contributors, a WWW based LMS Application Programming Interface (API) (ADLNet, 2004a, 2004b; Yang et al., 2004), varying elements from throughout the SCORM were used in one form or another in this research, including elements of the integrated IMS Simple Sequencing specification. Considering that at the time of writing the SCORM reference model consisted of over 800 pages divided over a number of documents, each focussing on a particular part of the reference model, it was beyond the scope of this literature review to indicate each an every element that was adopted from the model in this research. The various documents which comprise the SCORM reference model, the IMS SS model and the combined SCORM 2004 model contributed to the final form of the CCS system used in this research, which in turn drew heavily from elements of the aforementioned fields of online learning and adaptive systems. Having established the technical background for the CCS system thus far, the following section examines the context in which sequencing of learning materials can take place.

2.3.3 Learner Control, Program Control and Self Regulation

Learner Control (LC) is a term that has existed in one form or another for more than half a century, predating the existence of computer based adaptive learning environments (Doherty, 1998). LC does not mean 'total control' over the learning process by the learner, as they are still working within the confines of the available content and the overall learning objectives set out by a course of study. LC allows learners a certain element of control, such as which content they wish to view in what order and at what time. If a learner wishes to skip certain materials they can, while at the same time if they do not perform well on a quiz/assessment item, the learner could elect to proceed with the next set of materials without necessarily mastering the current content (Doherty, 1998). Research on LC is usually accompanied by that of learner Self Regulation (SR), where the ability of a learner to make decisions about their progress through a domain of knowledge is measured against their own internal desire to comprehend that content (Doherty, 1998; Ley & Young, 2001; J. Young, 1996). When a learner is placed in a position of having control over the way in which they use the educational resources presented to them, they can, depending upon the type of learner, make poor choices as to the use of the learning content (Doherty, 1998; Ley & Young, 2001; Neville & Bennett, 2004; J. Young, 1996). McCombs, cited in (Ley & Young, 2001), indicates that 'instructional interventions' can assist learners with poor self regulation skills to achieve better learning results (Donche, Vanhoof, & Van Petegem, 2003; Ley & Young, 2001; D. Young & Ley, 2003). While a significant amount of the literature on LC and SR does not necessarily cover the use of computer or WWW based systems as methods for improving student performance, many of the recommendations raised within these areas translate well from class and paper based methods to digital, computer based practices. Ley & Young (2001, p. 94-95) list four principles that "embody both effective and flexible guidance for embedding SR into instruction:"

1. Guide learners to prepare and structure an effective learning environment.
2. Organize instruction and activities to facilitate cognitive and metacognitive processes.
3. Use instructional goals and feedback to present student monitoring opportunities.

4. Provide learners with continuous evaluation information and occasions to self evaluate

Of these four listed principles, the CCS system addressed the first one partially in that students were given some guidance through the system with feedback mechanisms according to their performance. The second point inherit in the task design was also partially addressed by the CCS system in that the instruction and content was highly structured and organised, though whether it could be construed that sitting content-based assessments as a criterion for accessing further content could be considered as facilitating cognitive or metacognitive process is not clear. Points three and four were addressed by the CCS system, given the constant assessments, scores and messages at the end of each assessment based on the student's performance. Also, the clickstream system recorded all events within the system, though that monitoring was used for the research element of this study, rather than as information available to students about their own usage.

The assessments throughout the CCS system allow the learner to gauge and self-reflect (Ley & Young, 2001; D. Young & Ley, 2003, 2004) upon their level of topic understanding, whilst allowing the system to make decisions on whether the learner should proceed to the next section of content. Though the literature on LC would indicate that in most cases its use does lead to improved learner performance outcomes, the results are often inconsistent and difficult to separate from other environmental and pedagogical factors (Doherty, 1998; J. Young, 1996). Learners placed in a situation where they are expected to make choices in regards to their current learning performance and how to proceed with their learning in a knowledge domain can often make incorrect choices (Hannafin, 1984).

> “Because providing learners with control requires an ability to self-regulate behaviour, whereas program control does not, it seems important for research to examine the interaction between SRLS and the type of instructional control provided in CBI lesson” (J. Young, 1996, p.19)

It is this statement by Young that is at the heart of this research, though in the context of a university environment where the student learners have access to most if not all of their semester learning materials from the beginning of the semester, placed in an order deemed most appropriate by each course author. While the student learners are advised to work through the materials within a certain time frame and in a certain order, no functionality existed within the eLCMS at the time of writing to control or enforce these recommendations. Essentially, the eLCMS can be defined as LC as the learners can choose which materials to access in what order, with little or no ability for staff to ‘check up’ on how the learners are utilising the learning content, aside from formal assessments, such as assignments and exams.

Eom & Reiser (2000) and Young (1996) discuss research carried out by Carrier and Williams (1988) into LC versus PC within a computer based instructional (CBI) system, where a control group was taken through a short course in an LC mode of delivery, while a treatment group was given the same materials, though under Program Controlled (PC) conditions. Both groups were given a pre-test survey designed to gauge each learner’s level of Self Regulation Learning Strategies (SRLS), the reason for this being to give an indication of how learners from each group performed according to whether they had high or low levels of effective self-regulation (Blochl, Rumetshofer, & Wob, 2003; D. Young & Ley, 2003; J. Young, 1996). The LC group participants could move through the 24 learning events at their own rate, choosing to have certain content explained in greater detail, or being offered the choice of moving on or re-examining content that they did not perform well at.

Within the context of the CCS system, students could re-examine materials they had already completed, which was useful if they were on their first attempt at a section and scored poorly on that item. Because of the deliberate controlled nature of the CCS environment, the other options of 'moving on' or viewing items in greater detail (given that the CCS system had to have the same content as the eLCMS system, just in a different structure) were not available to student participants. The PC group in Young's paper worked through the same 24 learning events, though the sequence was linear and set. Essentially the results of the research detailed in Young (1996) indicates that learners with low SRLS ratings did not perform as well in the LC group as those with high levels of SRLS in the same group. Interestingly, those in the PC group with low SRLS benefited greatly from program control, though those with high levels of SRLS in the same group did not. This means that students who are deemed to be poor learners will make poor decisions when given control, such as skipping materials, not revising materials they have performed poorly at and not looking for higher levels of elaboration when offered it (Darbhamulla & Lawhead, 2004a; Khan, 2001; J. Young, 1996). These same learners, when placed within a system that monitors their performance and enforces revision and elaboration, and does not allow for content to be skipped, will generally perform better. As Brooks (1997, p. 137) states,

> "Given two persons with different skills, one with very high knowledge but low self-regulation, and the other with average knowledge but good self-regulation, the second person is more likely to be successful at a task in the given knowledge than is the first.".

Conversely, those with high levels of SRLS will perform extremely well in a learner controlled context, though not quite as well in the confines of a program controlled environment (Brooks, 1997). This is a relatively logical outcome, as learners who make the right choices and learn effectively will find program controlled environments stifling and inflexible (X. Li & Soh, 2004; McGrath, 1992; Zimmerman & Martinez-Pons, 1990).

Given the context of the learning environment in which this research took place, it is the application of this LC versus PC mode of delivery that was deemed worthy of further research. The research was designed to examine not just the performance differences between the two learner groups, those using the eLCMS (LC) and those using the CCS (PC), but how they used the system and what their opinions of the systems were. All of this within a working, 'live' university teaching environment using a range of learning materials that formed the basis of a WWW programming unit. This environment was comprised of a large population of students from diverse backgrounds with differing levels of technical skill, study habits and levels of self-confidence. Rather than looking at the LC implications of how this population of learners use the existing content delivery system and the materials within it, a PC approach was adopted, primarily for two reasons.

1) experience teaching the programming unit in question and other technical units indicates that it is very difficult to get students to complete the entire contents of a given week's worth of learning, even if the content is deemed as critical to their ability to complete the unit successfully. Students frequently ask questions that have their answers contained in the weekly learning materials, and when challenged on the content, indicate that they had not looked at it, especially if the material contained a large reading component. This exhibits symptoms of what Young's paper (1996) defined as poor SRLS, whereby when given the opportunity to control their own learning in a flexible, adult manner, often times students chose to simply avoid the work and seek answers directly from teaching staff instead, a trend referred to by Craig, Gholson, Ventura and Graesser (2000) as 'fact learning' rather than domain learning. By applying a PC approach, it was hoped that students could be exposed to each week's learning material and quizzed on it at a very

minimum of at least once. This would also help students avoid the trap of skipping materials with the intent of returning to them later, then not doing so (Ainsworth & Grimshaw, 2002; Khan, 2001). Within this research, student SRLS was examined by analysing the answers that the student participants gave in their online learning surveys as well as each student's clickstream usage data and the student assessment scores. These three items gave a certain triangulation of data from which student SRLS could, to a certain degree, be gauged.

2) to get a clear understanding of how students actually did work with their weekly learning materials, by analysing the clickstream information returned from the CCS system. This includes how much time was spent on a piece of learning content before the associated quiz/assessment was attempted, and if a section of content needed to be repeated, how the second attempt was approached by students (Barre, Choquet, Corbiere, & Iksal, 2004). While this researcher and other members of staff had certain beliefs as to how students regulated their own learning strategies and processes, the use of clickstream and log data on all facets of student access to the system would help shed light on the attitudes students had towards their use of online learning materials.

As established in the previous chapter, the specific presentation sequences encoded into the CCS system were derived from a teaching style this research has found most effective in instructing large numbers of students in technical materials. Horton (2000) advocates the use of more straightforward sequencing methods, stating that;

> "Sequential learning paths are utterly simple. You can go forward. Perhaps you can go back. It's hard to get lost in hyperspace with so few choices. And with a simple sequence, there are few distractions to draw learners away from the material being presented".

The CCS system, with its linear approach certainly did not allow for students to get distracted and move away on a tangent, as the system was not designed to be exploratory in nature. The CCS method was designed to focus students on the learning materials that needed to be studied, and to create that focus by controlling the sequencing of the materials and the access to them, this use of sequencing in line with the work of Horton (2000, p. 199);

> "Although presentation sequences may allow some optional topics, the primary pathway is linear. The structure lets the course designer control the order of learning experiences."

It is towards this end of creating and testing an environment of controlled content sequencing that this research, and the literature that has driven it, is directed. It is the combination of online learning for content delivery and adaptive systems for content sequencing that frame this work, in order to test the specific goals of encoding instructor-centred strategies (Hirumi, 2002; Tennyson, Park, & Christensen, 1985) into the delivery of a university WWW programming course. As Du Boulay (2000, p. 1041) states "It is important to acknowledge that non-intelligent but well-designed systems can be educationally excellent".

2.4 How Learners Perceive and React to Online Learning

As a component of this research sought to examine student usage of and attitudes towards the CCS system, it was important to gain a broader understanding research into learner attitudes to online learning environments. What components of an online learning environment affected student attitude, what features and functions were popular, and which were not. By gaining an understanding of the usability and attitude issues that arose frequently with learners in the online learning literature, a base for comparison could be developed to assist this research to identify the correct metrics and ask the appropriate questions.

2.4 1 Learner Satisfaction

Ardito et al (2004) examine the issues of e-learning design from a user-centred point of view, identifying as the top three issues raised by learners as presentation, orientation and functionality. Orientation is of particular note, and relevance to this study, as learners can become lost within the learning content of a system and find it difficult to return to an appropriate navigational reference point from which to orient themselves. As highlighted earlier in the section on adaptive systems, intelligent use of navigation and menu systems, particularly those where the navigation structure represents the structure of the learning content, can play a crucial part in how the usability of a system is perceived by the learners using it (Brusilovsky et al., 1996; Eklund & Zeiliger, 1996). Mazza and Dimitrova (2004) take the problem of understanding learner behaviour in online systems even further in their development of the CourseVis student tracking and visualisation tool, which tracks the WWW log (or clickstream) data for each student within a learning environment and then presents the data as visual representations of how students used a given system. The type of data tracked in CourseVis included frequency of access to the online course system, frequency of access to specific topics within a course, time spent within various parts of the course, use of collaborative tools such as forums and bulletin boards and actual progress through the course materials. The authors found that by using a tool such as CourseVis, shortcomings in the structure of a course or specific course materials could be identified and acted on quickly, while individual students experiencing difficulties with a course could also be singled out for specialised assistance.

In research conducted by Glenn, Jones and Hoyt (2003) analytical results indicated that learners did not perceive online learning to necessarily be beneficial due to a perceived lack of interactivity between learners and other learners and learners and staff. The research conducted by Glenn et al (2003) used WebCT as the online learning environment, a system which as stated before is designed as an asynchronous rather than synchronous environment, perhaps explaining the perceived lack of interactivity from the learners in that study. Swan, Shea, Fredericksen, Pickett, Maher (2000) note that the interaction between students and teaching staff, in a classroom situation, has long be held as a critical factor in both learner performance outcomes and learner satisfaction with a course. The authors feel that the translation from the classroom learning environment to the online learning environment does not diminish the importance of the student/staff communication relationship, but in fact makes it more critical, particularly in regards to learner acceptance of the online medium. Swan et al (2000, p. 517) go on to cite statistics that lead to their conclusion, somewhat myopically perhaps, that there are

> "three (and only three) course design factors that contribute significantly to the success of online courses. These are a transparent interface, an instructor who interacts frequently and constructively with students, and a valued and dynamic discussion"

Discussion boards and direct staff interaction were not elements included in the CCS research as the focus of this study was confined specifically to learning content delivery with the addition of rules which controlled that delivery. From this researcher's experience, students feel that there is no real substitute for direct and frequent contact with teaching staff, a reason this particular point is being discussed.

Psaromiligkos and Retalis (2003) and Swan et al (2000) identified that quality of learning materials has a significant impact on both learner performance and satisfaction outcomes. This quality can be measured in terms of the amount of content, the relevance of content (to the course, assignments and exams), consistency of content and the structure of content. Of course, these are just some of the measures that researchers in the field of online learning and education have tested against and deem important, though mostly from the 'developer' perspective. The problem with formalising 'quality' of content as a measure of learner satisfaction is identified by Richardson (2003) in that learners who are capable of making a distinction between high and low quality learning are usually themselves highly motivated, good self regulated learners. Those learners who use the "surface approach to studying" (Richardson, 2003) are generally less capable of distinguishing between high and low quality learning content and will tend to respond negatively regardless of content or delivery method

Parker (2003), Sandercock and Shaw (1999) found that access to online learning materials was well received by learners, especially from the point of view of being able to access lecture notes and other normal class based materials outside of the normal class times, particularly pertinent for those wishing to pre-read before class based lectures or workshops/tutorials. In the case of the Sandercock et al research the study was conducted in an environment where computers were not regularly used in any part of the teaching program, namely sports science, and thus one of the unexpected outcomes of the research was that the participant learners were not only positive about their increased level of access to the course materials, but also with the high level of improvement of their computing and information technology (C & I.T.) skills derived from having to constantly work with the university computer systems. While this improvement in C & I.T. skills was incidental to the actual purpose of delivering online content, that learners perceived it is a benefit indicates that learners can be satisfied with an outcome different to that which the course authors had intended. Like the work of Sandercock et al, Parker (2003) examines the reactions of students who have been introduced to an online learning environment (WebCT) in a tertiary level business course, where a bulk of the students had not used online learning previously. Parker's results indicate that students did feel that the use of the online learning environment provided a side benefit of increasing their computing skills, and that access to course materials online at any time was perhaps the greatest benefit of the online learning environment. Interestingly, 36% of students in Parker's study felt that the online learning environment contributed to their course workload, though the reasons for this were not explored in the research in question.

2.4.2 Learner Attitudes

Learner attitudes towards the delivery of courses and content can dictate the perceived success of the learning environment and outcomes, with (Paris, 2004) stating that "educators have known that learner attitudes and responses are interconnected and that a positive correlation exists between the two". Derrick and Polling-Cormick (2003) state that "learning is an action in which attitudes, intentions, and beliefs are acquired through the process of the educational activity", indicating learner attitudes can develop and evolve during the learning process. How learners feel about working with a learning system, be it online or in-class, generally dictates how they will go about their studies and in the end, how they will perform within that system (Gauss & Urbas, 2003). Thoennessen, Kashy, Tsai, & Davis (1999) comprehensively discuss learner usage of the Computer Assisted Personalized Approach (CAPA) system, providing some excellent examples of questions to ask and how to ask them of learners using online environments. Thoennessen et al describe the evolution of the CAPA system from a tool that served as an adjunct to traditional class teaching that was only occasionally used by learners through to a system that became the primary focus of most learners study processes. Similar to the findings of Glenn et al (2003), research into the CAPA system revealed that learner attitudes to the system evolved from indifferent to extremely positive in accordance to the amount of time placed into the system by teaching and instructor members of staff, a finding not dissimilar to those discussed earlier from Swan et al (2000) . The original goal of CAPA was to address the problem of too many learners in large courses and too few staff to address the individual learner needs. From a learner perspective, the CAPA system allowed for lecture notes and other materials to be accessed outside of normal class times, featured bulletin boards and forums where learners could place messages or questions and have them responded to by staff or fellow learners. Quizzes allowed learners to self-assess frequently or when they felt they needed to, while a homework feature allowed learners to map out the work they were required to do.

From a staff perspective, log or clickstream data allowed for usage statistics and quiz/homework performance of groups or individual learners to be displayed in an easy to read format. From this data staff could essentially determine an 'electronic attendance' list of which learners were working with the system and its learning materials and which were not. Learners who were not using the system frequently or who were struggling to perform well in the learning materials could be contacted by staff for further individualised assistance.

Research on the CAPA system indicates that learners are more motivated to use an online environment when it is accessible at any time they choose, and that the content they need is available within the system (Liu, Lin, & Wang, 2003). Indeed, how the content is delivered, whether it is done so adaptively, intelligently or linearly seems to be less important to learners than 24/7 availability of the system and the relevance (to the students studies) of the content within the system. Hayashi, Chen, Ryan and Wu (2004, p. 143) state that in information systems, such as those found in online learning, "the perceived usefulness factor was considered more influential than perceived ease of use". Quick turnaround times for feedback by teaching or instructing staff also appears to be a driver for positive student attitudes to online learning environments (Glenn et al., 2003; Swan et al., 2000; Thoennessen et al., 1999).

Ainsworth and Grimshaw (2002) also note that efforts in developing innovative and interactive methods for delivery of online learning can only achieve so much before the attitudes of learners become the limiting factor. In a system such as REEDEM (Ainsworth & Grimshaw, 2002) where learners can selectively make their way through a domain of knowledge, instructors were frustrated by some learners 'skim' reading practices whereby large sections of readings and other in-depth materials were simply skipped or only partially read by learners (Dimitrova, Sadler, Hatzipanagos, & Murphy, 2003). As Brooks (1997, p. 135) states "after all, instructors can do only so much to improve their teaching before a lack of student involvement becomes a limiting factor".

By delivering highly specific learning content in a structured, program controlled manner, this study aimed to see how learners used the system, if they benefited from it, and what their attitudes to it were. The usage of a program controlled, almost mandatory model of content delivery reduces the complexity of modelling student learning styles and adapting to them, as all learners with their individual traits of self-regulation and motivation are placed within the same learning context, with the same rules for progress and completion. It is the application of structure, in the case of this research, controlled structure, which could be used to compensate for the tendency of some learners to under-utilise the materials that have been developed for them. As Dringus (2001) states:

> "Self-directed activity is a goal to a certain point, but the misconception begins when learners are not given some structure from which they can plan their activities and make efficient use of their time. Structure and time management are closely related. Structure sets the tone for the order and time frame by which learning outcomes are achieved. Time management facilitates the experience of organized ongoing activity. Online learners must be given the essential materials, objectives, directives and deliverables in visible and comprehensive forms so that learners can adequately prepare themselves to learn the content area."

The last sentence in this statement is what the CCS system aimed to provide, and that which it was tested against. Instead of testing how well an instructional system reacts and adapts to individual learners, this study aimed to examine how individual learners reacted and adapted to a fixed instructional system.

The literature examined in this chapter has looked at the definitions of online learning, the components of online learning and recent development in online learning standards and tools. The technical evolution of adaptive learning environments, and how these relate to this study have been discussed, while student reaction to online learning and content delivery has also been addressed. From this literature basis, the following chapter will examine the eLCMS and CCS system implementations used within this study, how students used the systems and the data returned from that usage.

Chapter 3

3.0 Research Methods and Design

This chapter examines the research method and design used for this study, including the research context, the research instruments and the recruitment procedures used to obtain a population of participants. "Appendix A – Systems" contains a visual description of the eLCMS and CCS systems, with "Appendix B – Instruments" containing all the research instruments used. Recruitment and participants forms are contained in "Appendix C – Recruitment and Communications".

At this point it is necessary to define the terminology used within this chapter and within this study for the discussion of research methods and approaches. Research methodology is defined in this research as the study and selection of research methods best suited to the research questions and subsequent data collection techniques for addressing those questions. Method refers specifically to a defined research approach used to conduct a study, such as action research, case study research and survey research. Finally, techniques describe procedures used as part of a method or within a method to address a particular requirement, such as in this study which uses qualitative and quantitative techniques for data collection and analysis.

3.1 Methods Overview

Before examining the specifics of the methods used to conduct this research, some background and rationale for the selection of the methods is necessary. To begin with it should be stated that this research was essentially conducted using a heterogeneous approach, primarily using a field study for the research setting and the systems development method to drive the development of the research systems and instruments. This integration of methods allows for what Jicks (1979) refers to as triangulation, or "the combination of methodologies in the study of the same phenomenon" (p. 602). Quantitative methods for data collection were the primary techniques used, allowing for collection of performance data, system usage data and survey response data. Qualitative techniques were used to gain "convergent validation" (Jicks, p. 603) in the form of open-ended questions which allowed participants to make unstructured responses according to their likes and dislikes regarding both the eLCMS and CCS systems. These qualitative responses were used to validate interpretations made from the quantitative data collected against how participants actually used the respective content delivery systems, particularly the CCS. Using an example which will be discussed further in later chapters, it was discovered that many participants did not attempt assessment questions which required them to 'fill in the blank'. The initial interpretation of this phenomenon was that participants might have thought it too difficult to enter the exact required response (such as a section of programmatic code being entered), so did not bother to attempt such questions. This was essentially a qualitative interpretation of quantitative indicators in the data. When the qualitative, unstructured responses from participants were examined, several indicated that this interpretation was correct, and that 'fill in the blank' questions were generally left blank as they were deemed too difficult to get exactly right. Had just a single quantitative approach been used to address all three of the supporting research questions, the link between patterns of use within the respective content delivery systems and specific participant reactions would not have been available.

3.2 Possible Research Methods

Given the nature of this research, involving both the social and technical domains, with the technical being the content delivery mechanisms and the social being the students and staff using those systems, a number of possible approaches could have been used to conduct the study.

3.2.1 Action Research

Action research aims to "bring about change of practice, while creating knowledge at the same time" (Williamson, 2002) and is often used in exploratory research. Action research uses critical reflection on behalf of the researcher to identify weaknesses in an existing process and via appropriate research and development, implement change and attempt to measure any beneficial outcomes (Checkland, 1981). Action research usually requires that a solution to an identified problem be put in place and studied in a real-world context (Checkland & Scholes, 1990), often over the period of multiple iterative cycles. For this research, which is exploratory in nature, the focus was more on concept testing rather than implementing in a totally real world situation, which would have required the CCS system to replace the eLCMS at a school rather than single unit level, and to be developed over a series of cycles, so as to allow for reflection of each new iteration of the system (Burns, 1996). Also, action research is more specifically tailored to improving practice, while this study was looking at testing specific concepts with the long term view of putting those concepts into practice. To this end, action research was seen as a logical method for future research and development of the CCS system, but not as the preferred method for initial investigation.

3.2.2 Case Study Research

Initially a case study research method was envisaged as a likely approach to conducting this research, as multiple data collection techniques can be used, such as "interviews, observation, questionnaires, and document and text analysis" (Williamson, 2002). Case studies also feature a mix of qualitative and quantitative data collection and analysis methods, with qualitative data being the focus (Bordens & Abbott, 2002; Drew, Hardman, & Hart, 1996). Case studies aim to capture data from natural, real world environments, and for this reason share some characteristics with the field studies research approach, with Williamson et al (2002) explaining that the difference between the two methods can be difficult to distinguish, and can come down to the difference in measurement and data collection techniques. This distinction is raised as section 3.2.4 will show that a field study approach within an experimental design was one of the methods employed within this research. Also, in reference to the clickstream data recorded for users of the eLCMS and CCS systems, a form of document/text analysis was conducted in order to interpret participant behaviour whilst using the respective systems. As case study research is not typically suited to comparing and measuring differences between two systems, the method was not used to guide this research, though certainly a number of elements which constitute case study research were employed.

3.2.3 Survey Research

Survey research allows for the determination of "incidence, distribution, and interrelationships of certain variables within the population" (Williamson, 2002), which in the case of this research, was the population of students within a unit of teaching within a university environment. For this research, survey methods were used to examine the interrelationship between the way in which participants utilised the eLCMS and CCS systems and how they actually preferred to use the systems. The survey approach was essentially descriptive in nature, with a large amount of quantitative data collected for "fact gathering" (Williamson, 2002), with the provision of qualitative elements to support the empirical data (Dawson, 2002). Williamson et al (2002) describes the four primary problems with the survey method as;

1) Non-cooperation

2) Rival explanations

3) Accuracy of self-report data

4) Generalisability of results

In the case of this research study the concern of non-cooperation was apparent. As the following sections will indicate, during a pilot study of the CCS system and research instruments, a large sample population produced little workable data due to a low level of cooperation. This was addressed in the main study by using a more 'captive' population and integrating the research into the teaching program to a greater extent than seen in the pilot study. Rival explanations were addressed by the inclusion of the open-ended response questions interlaced with the closed, scaled response items. In several instances, the qualitative data gathered from the open-ended question items helped eliminate a number of rival explanations for identified phenomenon in the quantitative clickstream and survey data (such as the aforementioned example of the fill-in-the-blank questions being left unanswered). Accuracy of self report can be difficult to mitigate as humans in general can say one thing but do another, especially if the situation involves portraying oneself in a positive light to others (Anderson & Burns, 1989; Williamson, 2002). Later in the data analysis chapters some examples will be put forward which indicate that some participants within the study acted one way, in terms of pre/post test performance and clickstream usage of their respective content delivery systems, yet portrayed their usage and learning habits in another way within the survey. The survey method employed within this research allowed for a relatively high level of generalisability as the target population was highly focused, while the response rate was also relatively high at greater than 50%.

In order to attain a high participation rate and subsequent high completion rate of all data collection elements, it was decided that the format of the data collection instruments as a whole, particularly the surveys, should be electronic in format, with high proximity to the actual eLCMS or CCS system depending upon which group a participant was randomly assigned to. Williamson et al (2002) discuss the problem of participation and response levels when using the survey mechanism, indicating that participation and response can often be linked to the amount of effort required on behalf of the target population to take part in the research (Drew et al., 1996). As participants in this study were frequent users of online environments, it was decide that a well structured survey featuring quantitative and qualitative elements would in the end produce more usable data for analysis than face to face interviews. While interviews may have been more informative and further reduced the problem of rival explanations of patterns seen in the performance and usage data, the likelihood of receiving a high level of participation and response to the interview survey method seemed substantially lower. As the participant recruitment and participation forms in "Appendix C – Recruitment and Communications" indicate, participants were asked if they were willing to take part in face to face interviews at the completion of the study, to which a majority indicated they would not.

3.2.4 Experimental Research

Experimental research allows for the examination of cause and effect relationships between pre-defined variables, with statistical probabilities being used as mechanisms to draw inference from the results of experimental data (Williamson, 2002). Experimental methods primarily examine independent and dependent variables, with the independent variable being the element under investigation, while the dependent variable is the result of the application of the independent variable. Within this research the independent variable is defined as the mechanism for learning content delivery, either within a controlled (CCS) environment or a non-controlled (eLCMS) environment. The dependent variable that can be statistically measured is the learning performance of the control and treatment groups according to their respective content delivery systems. Experimental research is largely concerned with controlling as many elements as possible within a specific setting under study (Bordens & Abbott, 2002; Williamson, 2002), so that only the variables being tested are those that can identified as having an impact on the resulting data (Drew et al., 1996; Poling & Fuqua, 1986; Williamson, 2002). Williams et al (2002, p. 129) discuss the use of control groups for the purpose of "the differentiation of two basic conditions: exposure and non-exposure to the treatment condition of the independent variable". The limitation of experimental research when used as a singular research method is that a causal relationship between an independent and dependent variable can be established, but the underlying reasons for that causation may not be apparent (Bordens & Abbott, 2002). It is for this reason that the experimental method has been allied with the survey method, to provide further fidelity as to causal relationships identified from the attained experimental data. Random assignment is a key requirement when using control groups in experimental research, and was used within this research when creating the control and treatment groups.

3.3 Selected Research Methods

The previous section examined some of the research merthods which were investigated as possible approaches to use for conducting this research. While no one method in isolation was considered suitable for conducting the entire research process, elements of each were identified as being useful for different stages of this research. To this end, the survey and experimental research methods were deemed as appropriate to the data collection and analysis requirements of this research (see next section), while the iterative development cycle and the real-world focus of the case studies were also integrated into the application of the research process. Essentially, these elements were integrated into a systems development approach, this approach controlling the development and implementation of the CCS system and the research design and instruments relating to the survey and experimental elements of the research (referred to as the experimental and survey phases). Figure 3-1 shows the overall mix methodological approach used within this research.

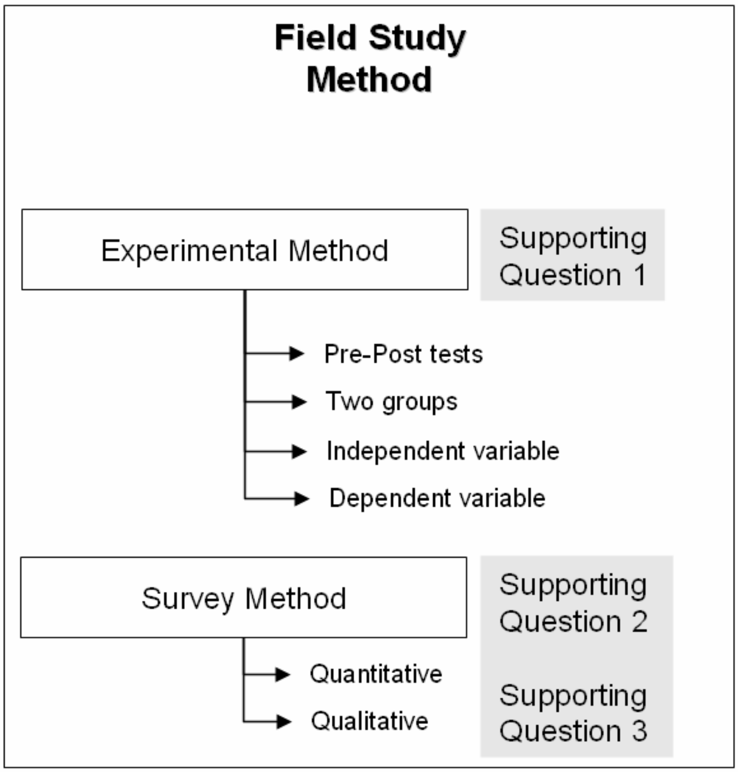


Figure 3-1: Mixed methodological approach used for research

3.4 Mapping Research Questions to Methods

Figure 3-2 shows the relationship between the primary and supporting research questions, the data collected to address these and the methodological approaches used to gather them.

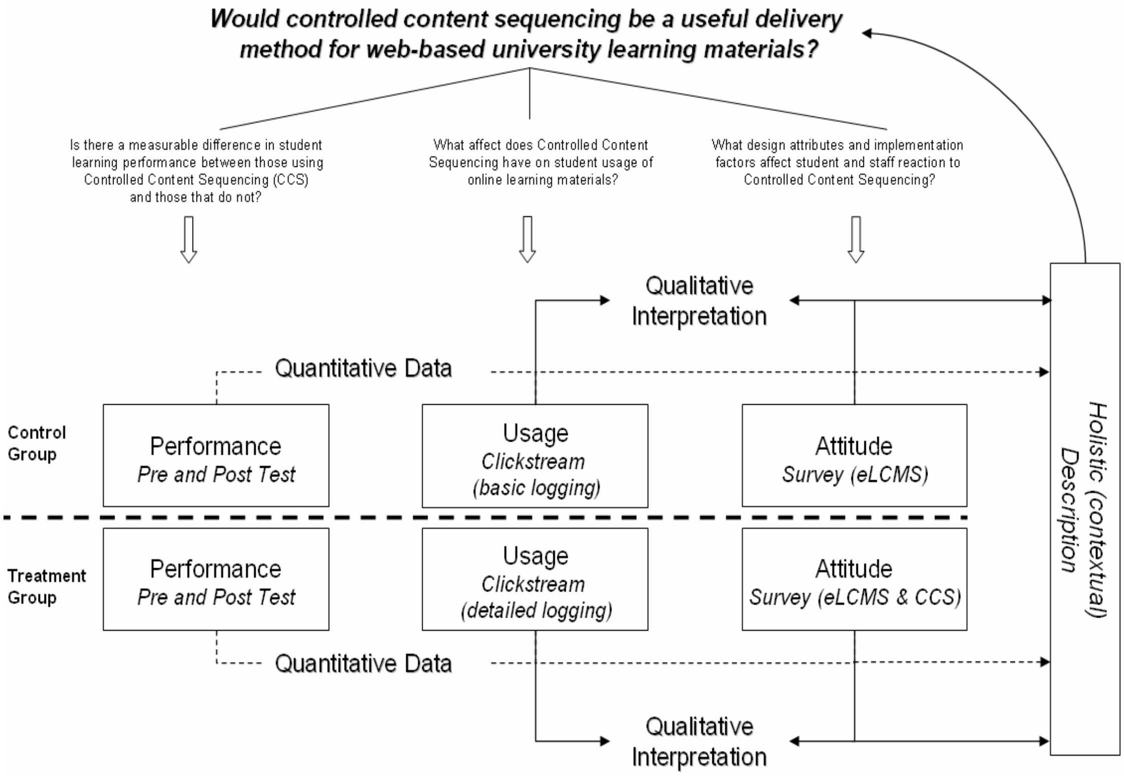


Figure 3-2: Research questions mapped to methods

As Figure 3-2 shows, the quantitative data crosses all three of the variables for measurement within the study, while some qualitative interpretation of the usage data, when combined with actual qualitative data returned from the survey instrument provide for an overall holistic representation of how participants utilised the content delivery systems and what their actual reaction to the systems were. This selection of multiple methods for the purpose of data triangulation and validation fits within Jick's (1979, p. 603) "continuum of triangulation design" between a "convergent validation" model and that of a "Complex Design" allowing for the holistic representation of a phenomenon as a whole. The combination of quantitative and qualitative methods allowed for the researcher to collect and interpret data from the researcher's frame of reference regarding teaching and learning, external to the participants and their interactions with the content delivery systems. Participants provided data in their testing performance and usage of the respective systems, as well as providing responses from their own perspective based on their beliefs as learners and users of learning content. The use of a mixed or "multi-method" approach to this research was further supported by the work of Nunamaker, Chen and Purdin (1991) who believe that while some research domains are narrow enough to be explored within a single method or approach, that there also exists research domains that are sufficiently broad that they can embrace a number of different methods. Nunamaker et al (1991) discuss the research life-cycle, which essentially entails "concept-development-impact" (p. 92), a life-cycle which this research was built upon, in that the concept of the CCS gradually developed, was implemented (developed) within a software system over several iterations before being presented to the end user population of students and staff to gauge their reaction to the system (its impact). This research life-cycle is similar to that discussed in for action research in section 3.2.1, except that the multiple iterations of the CCS and data collection instruments development took place mostly outside of a real-world context. The testing of the CCS and eLCMS systems and data collection instruments within the pilot study, which resulted in changes to both systems and instruments for use in the main study is an example of elements of action research being integrated with the systems development method.

Figure 3-3 shows a detailed breakdown of the (Nunamaker et al., 1991) systems development method with its expanded multi-method approach. In the case of this research the initial theory was actually a question regarding the efficacy of control mechanisms for delivering online learning materials to students.

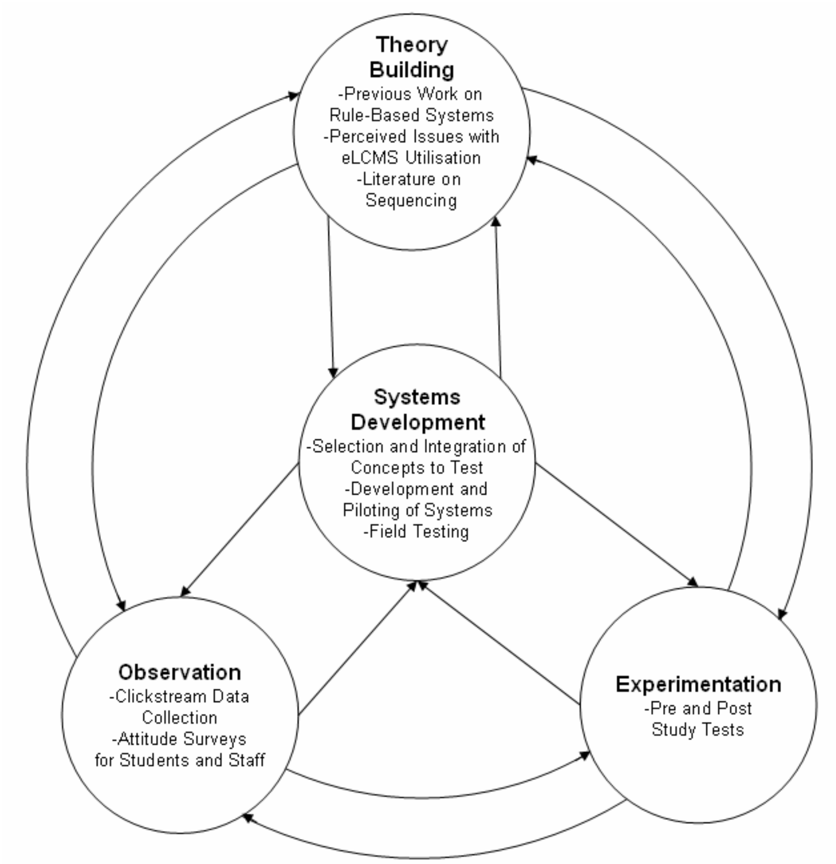


Figure 3-3: Multi-method approach to Information Systems research

3.5 Systems Development Method

This section of the literature review presents evidence supporting the overall research method used to conduct this study and the rationale for the design and procedures used for that data collection process.

The research approach of this thesis is exploratory in nature, examining the reactions of university students and staff to the concept of Controlled Content Sequencing (CCS) in the delivery of online learning materials. The basic research approach adopted, as discussed previously, used a two group strategy, with a control group using an existing and established content delivery system, while the treatment group used the experimental, CCS system. The systems development method within the context of information systems research (Williamson, 2002) provided the overall approach by which this research was conducted. The systems development model is defined by Williamson et al (Williamson, 2002) as being more of an applied research method rather than a basic, or theory building approach to research. Such a method was highly suitable to this research given the applied nature of the study, where an information system was developed, in this case the CCS, for the purpose of "targeting a specific problem relating to the introduction or functioning of an information system" (Williamson, 2002, p.149). In the case of this study, the information system was the CCS, with the specific problem relating to how students, and staff, would react to the rule-driven, performance controlled delivery of online learning materials, where a system existed that placed no such controls on content delivery. Williamson et al (2002) makes an excellent suggestion with regards to the systems development method, stating that "if the scope of the prototype is closely monitored to conform to an absolute minimum necessary to illustrate the theory, it is possible to complete one cycle of system(s) development based on the given theory" (p. 149). This statement was intrinsic to the evolution of the CCS system as designed for this research, as the system contained just those elements which were identified as critical to testing the independent variable, in this case the CCS approach, without adding extraneous elements which were outside of the scope of the research.

The CCS system contained just the content, the assessments and the rules for progress, with no other 'features' to distract from the central focus of examining the viability of controlled content delivery. Johnstone and Pennypacker, in Poling and Fuqua (1986, p. 64) discuss the issues of technological systems and behaviour, and how "the questions that direct technological research are generally about methods of controlling behaviour", a statement that goes some way to describing the underlying method of this study. The difference between this statement and the actual method of this study is again addressed by the same authors when they state that

> "The difficulty lies in the fact that basic research questions that ask about the influence of variables at the same time lead to statements about controlling behaviour, whereas technological research questions (especially those that are asked in order to analyze the nature of a procedure's effects) may result in learning about some relatively fundamental influences on behaviour" (p. 64).

This statement encapsulates the desired outcome of the method applied to this research study, to apply an effect, in this case a technological one, and to examine the outcome in terms of behaviour, behaviour being primarily measured in terms of performance and attitude data gathered from the student and staff participants.

The system development method calls for field testing rather than situated laboratory testing (Bordens & Abbott, 2002) of the information system, and in the case of this research the 'field' was the actual classes of students enrolled in a tertiary unit of study. Williamson et al (2002) describes the three main steps involved in the systems development method, which in the case of this research, is the preparation stage of the larger field study approach.

Step 1: Concept building

The construction of a meaningful research question, investigation of the functionality and requirements of the system and studying other disciplines for other ideas and approaches

Step 2: System building

The construction of the prototype system through the following steps

> ***Step 2a: Develop a system architecture***
>
> Developing an architectural design and defining system functionality, components and interrelationships
>
> ***Step 2b: Analyse and design the system***
>
> Designing the database/knowledge base and processes to carry out system functions, developing alternative solutions and selecting one of them
>
> ***Step 2c: Build the (prototype) system***
>
> Learning about concepts, framework and design through the building process and gaining insights about the problems and the complexity of the system

Step 3: System evaluation

Observing the use of the system by case study or field experiment, evaluating the system through laboratory or field experiment, developing new theories/models based on the observation and evaluation of the system, and consolidating experiences learned.

(Williamson, 2002)

For this research Step 3 of the systems development method was expanded to incorporate the outcomes of the original field development and implementation of the CCS (and eLCMS) systems. The three added steps were;

Step 3a: Experiment

Once the systems development process had been completed (including the pilot study) and the desired research elements had been incorporated into the final CCS system, both it and the eLCMS were presented to participants in a two group experimental design. The experiment called for both groups to complete common pre-test item, then complete their learning materials using either the eLCMS or CCS dependent on group, after which they would complete the common post-test item. The aim of Step 3a was to establish if there was a measurable difference in learning performance (supporting question one) between those participants using the eLCMS and those using the CCS system.

Step 3b: Surveys

Surveys were added to the system evaluation stage of the system development method to allow for direct feedback from users as to their experiences with and attitudes towards the two systems used in the study. Using both quantitative and qualitative techniques within the survey method, both student groups (control and treatment) and staff were presented with surveys which were designed to allow those users to evaluate the systems and the concepts integrated into them (supporting question three)

Step 3c: Evaluate

By combining the outcomes of the experimental data returned in Step 3a and 3b, and examining those results in light of the clickstream data (supporting question two), an overall evaluation of the CCS concept could take place, addressing the primary research question of "Would controlled content sequencing be a useful delivery method for web-based university learning materials?".

The systems development approach, especially steps one and two as described by Williamson (2002), is primarily concerned with information systems and information systems development. The system developed for this research was not just an information system, but rather a learning and instruction system, as it essentially added value to the information contained within the learning materials it managed and delivered. The three main steps within the systems development method can continually be fed back into the steps above, so that original concept building in step one may change as a result of work done within the multiple parts of step two, or as a result of the step three evaluation. In the case of this research, the step one concept building cycle was adjusted and refined over the period of several months as a result of initial system development in steps 2a and 2b, where the 'feature set' of the system kept becoming a distraction from the central research questions around which the study was designed. Getting the prototype system to work in a way that allowed for the collection of all the data elements necessary to address the research questions proved more difficult than expected, though once these issues were overcome, step 2c went ahead in a relatively straightforward manner.

The system development method gives the researcher a tool for linking academic research goals to software development in a practical and applied manner, where the software becomes only a tool to allow for the collection of data against which the research questions can be analysed. This method can be used to build research structures that collect qualitative and quantitative data, which in the case of this research is obtained within step three, where the usage of the system in the field and the related research instruments allow for the evaluation of the system against the criteria outlined in the research questions.

When discussing the field of information systems development and prototyping, Olfman (1984, p. 9) identifies the "socio-technical framework", essentially describing the developers and users of information systems, and the actual information systems used to complete the information processing tasks. In the case of the this research study, the student and staff participants provide the social, user-centred context of the study, while the eLCMS and CCS systems provided the technical framework which allowed for collection of the social, user data. Olfman goes into great detail about the steps necessary for the successful development of IS applications, providing a good summary of the use of pilot systems within any development process, stating that pilots "provide valuable feedback from users in a working environment" (p. 9). While Oflman discusses the concept of a pilot primarily from a technical systems perspective, this research was designed with a pilot system to test not just the technical system but the research tools as well, to ensure that the technical operation of the instruments, and the data they collected, were reinforcing the internal validity of the research aims and not generating extraneous results (Bordens & Abbott, 2002; Burns, 1996; Williamson, 2002). The role of IS research methods, have, according to Galliers and Land (1987, p. 901) expanded to "include behavioural and organisational considerations" rather than just the technical considerations that were once seen as the purview of IS research. This is important as the systems development method was chosen as a research method suited to developing a learning system for conducting academic research and using that learning system as a data gathering tool only, so that the research, not the tool, is the focus of the effort.

3.5.1 CCS Systems Development

Given the discussion thus far on the selection of methods for both system implementation and research design, some examination of the actual development details would be useful at this point. The underlying model of the CCS system was adapted from earlier work on a flexible rule authoring system for WWW content delivery (Brown, 2002). The underlying rule processing functions from this earlier work were integrated into the CCS design, as was the data storage model used in the previous system. The data storage model adopted from the earlier work was very flexible for representing attributes and attribute values for each type of object stored within the system, including learning items, section details and week (or module) details. In the original system, which was in an advanced prototype stage of development, support for multiple users had not been implemented, due mainly to time and technical issues. The problem with multiple users arose from the fact that the storage model was essentially a frames based approach where an object was defined in one part of the database, whilst all the attributes which described the purpose and the state of each object was stored in a separate table. Referencing each user's current state within the set of learning materials (such as items completed and scores for assessments) against the pre-defined states set within the system for the learning materials initially proved cumbersome and inefficient. Eventually the issue was resolved by simply copying all the pre-defined settings for those objects/attributes that could be changed (such as completed values, score values and attempt values) as attributes assigned to each user's account object. When rules within the system were called to check a user's progress, the rule would compare the pre-defined setting (attribute value) against the changed setting (attribute value) for the current user object. Every time a new user was added to the system, the current settings of the learning materials was added as attributes against the new user account.

Other technical issues included how to manage the interface elements so that every time an item was clicked on the navigation frame the application would re-load, check all object/attribute settings with a set of rules, from which the interface could be re-drawn with the appropriate available items and messages. This process called for a significant amount of work with server and client side technologies to get the sequencing system stable and reliable. Some effort was also afforded to making the system as 'tinker proof' as possible, so that student users could not re-submit assessments or gain access to learning materials out of sequence. Not including the assessment and learning material files, the CCS application consisted of five main application files and a total of approximately 3700 lines of code. In all, the systems development time was five months of full time coding, not including the development of the learning materials, assessments, pre/post tests and surveys.

A detailed description of the technical aspects of the actual CCS system is outside the scope of this research as it is the use of the system which is the focus, not how the system worked. Sufficed to say that multiple iterations of the design, development and testing cycle occurred and that the overall development of the system was non-trivial.

3.6 Research Design

Though the overall method for this research was couched in terms of a systems development approach, the actual implementation of the study had two distinct elements, the experimental phase and the survey phase. The experimental phase consisted of the student interactions with the eLCMS and CCS systems, while the survey phase consisted of the student and staff participants filling in online surveys relevant to their roles in this research. Figure 3-4 provides a graphical summary of the design used in this research.

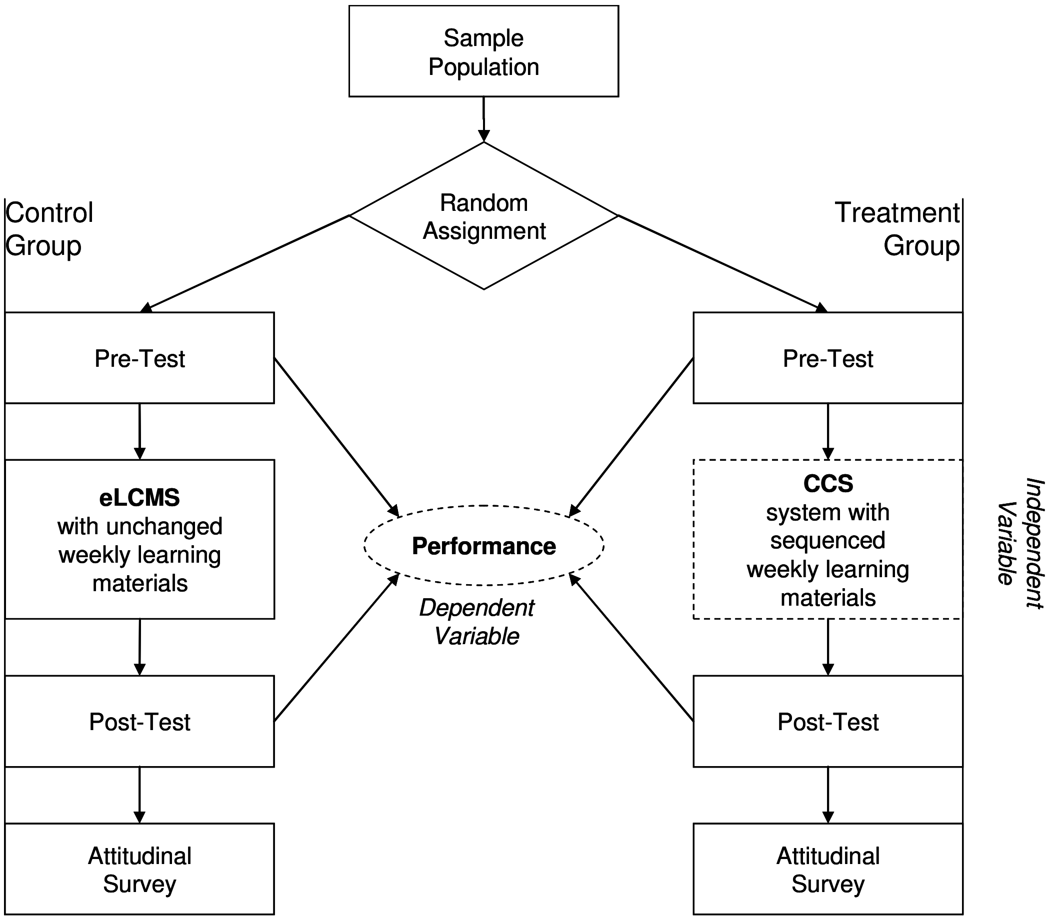


Figure 3-4: Overall research design

3.6.1 Experimental Phase

The experimental phase of this study involved student participants from the sample population being randomly assigned (Drew et al., 1996) to control and treatment groups and interacting with the eLCMS and CCS systems respectively. The two group design was adopted in order to allow one group to receive the treatment, in this case use of the CCS system, while the other group used the normal eLCMS system, in this case the control group. Borderns and Abbot (2002, p. 301), in discussing the use of a two group experimental design with pre and post tests applied to each group, states that "It is simply a mixed design with pretest--posttest as the within-subjects factor and with treatment versus no treatment as the between-subjects factor".

3.6.1.1 Pre-Test and Post-Test Design

In the experimental phase a sample from a larger population is divided into two "independent groups" (Drew et al., 1996, 118), a control and a treatment, with the intent that the treatment group receive the independent variable, in this case the CCS version of the weekly learning materials, whilst the control group receive the standard weekly learning materials. The dependent variable in this experimental phase is the performance measures between the control and treatment groups, performance being measured in terms of scores returned by both groups from identical pre and post test instruments. Performance is the criterion used to measure the dependent variable in this study, as "one cannot measure learning directly. One can, however, infer that learning exists or has occurred through the observation of certain performance dimensions" (Drew et al., 1996, p. 290). The pre and post test items were identical, with the pre-test being given to participants from both groups under the same conditions, that is, at the beginning of the teaching week in which the study took place, and with weekly learning materials being hidden from both groups until the commencement of the study. As Poling and Fuqua (1986, p. 23) state "the purpose of experimentation is to detect functional relations", which in the case of this research, applies to the development and implementation of the CCS for the delivery of learning materials, to which only one group had access. By using a two group, control/treatment approach within the experimentation stage of the research, "changes in the dependent variable can be attributed with little or no ambiguity to the effects of an independent variable".

Bordens and Abbot (2002, p. 302) use a hypothetical new teaching method as an example of how a two-group, pre and post test design would be used in order to test the efficacy of a new method.

> "Imagine you are interested in whether using computers in a second-grade class affects the children's knowledge of scientific principles. You obtain a sample of 100 second graders. You randomly assign 50 of them to a new teaching method involving computer-aided instruction. These participants constitute your experimental group; the remaining participants are your control group. You give a pretest of scientific principles to all 100 students then provide computer-aided instruction to your experimental group (the control group continues to get the usual instruction). Finally, you give both groups your posttest. Imagine you find that your experimental participants show an average gain of 20 points from prettest to posttest, whereas your control group shows an average gain of only 2 points. You could then conclude that your new teaching method and not some other factor was responsible for the observed change".

3.6.1.2 Internal and External Validity

Experimental research designs are very much about control, control of most if not all facets of a research implementation in order to be confident that the causal relationship between the independent and dependent variables actually exists, untainted by external influences (Bordens & Abbott, 2002; Drew et al., 1996). To this end, the experimental phase of this research controlled the following;

- access to the learning materials prior to the study
- the order in which participants in both groups accessed the various instruments, primarily the pre and post tests
- the questions and sequence of questions in the pre and post tests, keeping both instruments identical for both groups to give precise measures of performance differences between the two

While the literature on research methods, experimental methods in particular, make frequent reference to the importance of addressing internal validity before making assumptions based on analysed data, the concept of external validity is also addressed, particularly in cases where research is designed to have practical, applicable outcomes. External validity refers the how results from an experimental design translate into real world situations which the research was design to test or simulate (Poling & Fuqua, 1986). As this study was designed to explore the use of the CCS method for content delivery, the level of external validity was designed to be high, as the outcomes of the research would be indicative of whether integration of CCS methods into online teaching would warrant further development within the current university teaching environment and by those looking to apply a level of control to their content delivery, regardless of environment, notwithstanding resources issues for staff and materials issues for students.

The experimental phase of the research primarily addressed the collection of quantitative data to measure the impact of the independent variable on the dependent variable, addressing the first supporting research question of *Is there a measurable difference in student learning performance between those using the Controlled Content Sequencing (CCS) and those that do not?*

3.6.2 Survey Phase

The survey phase of the study was designed to be descriptive in nature, specifically asking participants from each of the three populations (control/treatment/staff) what their usage patterns and attitudes towards the eLCMS and CCS systems were. While the respective pre and post test scores for the two student groups, combined with each group's clickstream data suggested a usage style for each user, the survey mechanisms were designed to confirm and expand upon such data with responses to specific statements. While the next section examines the survey instruments in detail, literature supporting the use of the survey mechanisms is provided here.

Drew et al (1996, p. 302) refer to survey or questionnaire instruments as "the link between the researcher and the data", which in the case of this study is particularly true, given that the survey instruments represent the most formal face of the study for all three groups. To clarify this statement, the student participants in the control and treatment groups provided data in the experimental phase somewhat unconsciously, by simply using their respective systems, and by completing the pre and post test instruments. Within the survey mechanism, the student participants were working more directly with the data collection instrument, responding to statements regarding their use of the respective systems and their attitudes towards them. Given that participants, both students and staff alike, had to read statements and make a considered response against them, these statements needed to be "clearly worded so that there is minimal chance for the respondent to be confused". Drew et al (1996) highlights a number of possible traps for researchers developing survey and questionnaire instruments, including placing two statements in one, ambiguous statements where the desired response is not understood or misinterpreted by the respondent and the fine balance between the use of too many colloquialisms or language that is too technical. The term statement is used as the majority of the survey items were statements against which participants could rate their level of agreement (to discern attitude), rather than direct questions, which are better suited to yes/no responses (Bordens & Abbott, 2002).

3.6.2.1 Likert method questions

Given that the survey phase of the research design was created in order to directly measure and confirm participant attitudes towards the eLCMS and the CCS systems, a measurement was used that is well suited to attitude relevant data, in this case, the Likert method (or Likert scale). Burns (1996, p. 460) describes the Likert method as;

> "the researcher selecting a set of attitude statements, to which subjects are asked to indicate their agreement or disagreement to each statement along a five point (or sometimes longer) scale ranging from 'strongly agree' to 'strongly disagree'. A subject's score is tabulated by assigning a numerical value to each of the answers".

For this research, the Likert scale was used for six items (statements), consisting of the five point scale items discussed in Burns, with the addition of an NA, or Not Applicable response at the end of the scale. The Likert scale was chosen as the primary survey response mechanism due to the attitudinal focus of the survey instruments, and "the fact that the method produces more homogenous and increases the probability that a unitary attitude is being measured, and therefore that validity (construct and concurrent) and reliability are reasonably high" (Burns, 1996, p. 461).

3.6.2.2 Closed questions

While the survey instruments were largely comprised of Likert scaled statements focussed on both the eLCMS and the CCS systems according to the survey recipient, the instruments also included closed, open-ended and partially open-ended items. The closed items include questions with yes/no, true/false or agree/disagree or essentially any statement where the participant could select one choice only from a predefined list of responses. These items allow for greater uniformity and reliability, but require care, as a poorly worded closed item which does not match the available responses will lead to confusion in the respondent and produce answers that are inappropriate (Bordens & Abbott, 2002; Burns, 1996).

3.6.2.3 Open-ended questions

Given that the survey instruments in this study were aimed mainly at collecting quantitative data against statements relating to participant attitudes, the use of open-ended, qualitative items was restricted to relatively simple statements of the type 'things you liked most', 'things you liked least'. The reason for including open-ended questions was to capture any attitude data from the participant groups that was not included in the closed statements and to "supply a frame of reference for the respondents' answers, coupled with a minimum of restraint on their expression" (Burns, 1996, p. 473). Essentially, the open-ended responses in the survey instruments were designed to fill in the blanks of the closed, highly structured items and to facilitate "a richness and intensity of response".

3.6.2.4 Partially open-ended questions

The final category of statement used in the survey instruments across the student and staff participant groups was what Borderns and Abbott (2002) describe as partially open-ended items, where a predefined list of responses is provided, with the addition of an ‘other’ option, against which is a place for respondents to enter some unstructured text. In the case of this research, only one partially open-ended item was included in the control group survey instrument, while the treatment group and staff survey instruments contained two. This response was provided to cover scenarios where participants were asked to list online learning systems they had experience using, but were not provided on the predefined response list.

Overall, the items presented in the three survey instruments (control/treatment/staff) were mostly of the closed and were designed to contain statements against which the participant could indicate a level of agreement or could select from a predefined list of responses. Some open-ended items were included to capture data not represented in the original survey questions, and to allow participants to expand on any responses they had provided in earlier stages of the survey. Great care was afforded to the design and presentation of the survey, to the wording of the items to avoid ambiguous or contentious statements and to the length and complexity of the instruments.

This research was conducted within the framework of implementing and evaluating a specific method in delivering online learning environments. The data collection phase took place within a university school of computing and information science, within existing units of teaching containing sizeable student populations. The students enrolled within the university school were the primary populations from which data was gathered to support the research aims of this study, whilst academic staff members provided a secondary source of data. The students represented the primary data source population for this study due to the research questions driving this research, which focussed on how students would react, in terms of performance and attitude, to the use of CCS methods for online learning content delivery.

Given that the school in question relied almost totally on the WWW environment for learning content delivery and management, staff members were seen as significant stakeholders in this research, as their opinions and reactions to the proposed use of CCS would serve as useful counterpoints to the reactions presented by the student population.

3.7 Research Environment

Within the context of this study the term 'week' has been used generically to refer to a single weeks worth of teaching materials, though at the university in some schools and faculties use the term 'module' to describe a scheduled week worth of materials and instruction. Teaching materials within units typically comprise lecture, workshop, readings (from textbooks) and any other activities a unit co-ordinator may deem useful to a given week of learning and the semester as a whole.

Within the school in question, students access the weekly learning materials such as the lecture slides, workshop instruction sheets, workshop files and online readings via the existing learning content management system, referred to from this point on as the eLCMS. The core learning materials would usually be placed on the eLCMS by teaching staff at the beginning of semester so that students had access to the entire semesters' worth of content at or near the beginning of semester.

Attendance in lectures tends to be high for the first two to three weeks as students become accustomed to the workload and study requirements, at which point a certain percentage of students tend to see the weekly lecture as optional rather than essential. Workshops usually have a higher attendance rate throughout the semester, particularly close to assignment submission time, a problem identified in the first chapter as one of the reasons behind this study.

Young male students comprised a bulk of the student population, primarily in the areas of information technology and computer science, with students coming from Australia, Indonesia, China, Singapore, Hong Kong, Malaysia, India, Pakistan, Sri Lanka, Africa and Europe. The school has a very multicultural teaching and learning environment, though English is the only spoken and written language. This point is raised to highlight the very real problem that the English as a Second Language (ESL) can sometimes create for international students and their studies within the school, especially from a self confidence point of view. As the data analysis chapters will later indicate, some students tended to suffer from self confidence issues in regards to their own ability to work with learning materials, especially if they are asked to 'go and download the materials' and devise their own study procedures. Another issue that arose from the diverse background of the student population within the school, and subsequently within this study, was that judging the technical acumen of students proved difficult, and some assumptions made about that level of technical ability may have in turn affected the manner in which participants interacted with the CCS system.

3.8 Research Process Implementation

Sections 3.1 – 3.4 presented literature detailing the overall research methods used to conduct this study, with a focus on the establishment of a two-group experiment and the basic design of the data collection instruments presented to these groups. This section will build on that discussion by examining the processes used in implementing the selected methods and research instruments through the lifecycle of this study. The lifecycle of the data collection portion of this study refers to the use of a pilot study and a main study, with the two studies running consecutively over two semesters, each in a different unit of teaching. The pilot study was used in order to field-test the CCS system, the two-group experimental model and associated instruments, as well as the participant recruitment and management procedures devised for the study. The pilot study was designed to evolve the research method and instruments, including the CCS system, in a process derived from the three stage prototyping concept proposed in Williamson et al (2002). The pilot study was designed to return data about the effectiveness of the research method and design and of the CCS system itself, and was not meant as a source of data for analysis against the research questions upon which this study was based. Changes to the research design and instruments as a result of issues arising from the pilot study are detailed in a later section of this chapter.

The following are the five main sources employed to gather data for this study, each of which will be examined within this section.

1) Pre and Post test instruments for establishment of baseline and performance outcomes;
2) Survey instruments presented to members of the student control and treatment groups;
3) Clickstream data gather from student control and treatment group, with the treatment group data being the more detailed;
4) Scores returned by treatment group participants within their CCS system assessments; and
5) Staff survey

3.8.1 Pre-Test Instruments

The Pre-Test instruments were designed to gauge each student's existing level of knowledge of the learning content to be presented during the week in which the study was to be held. Neither group had access to the respective learning materials used within the week that the study took place, the materials becoming available to individual participants only once they had completed the Pre-Test instrument.

Multiple-choice and true-false were selected as the question on the Pre-Test as they are easy for participants to use, allow for relatively straightforward data collection through a HTML forms interface and make for simple automated scoring of test results (Byers, 2001; Darbhamulla & Lawhead, 2004a). In the original design of the Pre-Test approximately 50-60 questions were envisaged as being needed to gain an understanding of each participant's current level of expertise in the topic area covered within the study week. As the Pre-Test developed it was decided that a Pre-Test of such length may cause participants to abandon the research before they even started, and that given there was one week's worth of learning content, too many questions in the Pre-Test may leave little room for authoring relevant questions for use within the CCS materials.

The Pre-Test instruments on both the pilot and main studies contained 30 questions, with each question being of approximately the same level of difficulty. Each correct question was worth a score of one, so 30 correct answers equalled a score of 30 out of 30. While the questions were not weighted, they were by no means general knowledge oriented, being highly specific to all the learning materials contained within the study week. This was one of the primary reasons that access to the learning materials was disabled in the eLCMS leading up to the beginning of the study, so that students entering the given week, regardless of control or treatment group, should have been entering with approximately the same level of knowledge, at least from a unit teaching perspective. It is likely that some students enrolled in the computer security or WWW or web programming unit (for the pilot and main study respectively) had prior experience with the materials within the study week, such as if they were repeating the unit, or if the areas were within their existing expertise or interest outside of the unit in question. A time-stamp was created upon loading the Pre-Test instrument and also upon submission of the completed Pre-Test, providing the time interval taken for each participant to complete the instrument. No form validation or time limit functions were incorporated into the Pre-Test instrument, and none of the form fields had default values set, essentially setting all the answer response fields in the form to blank.

No score for the Pre-Test was provided to participants in either of the groups for a number of reasons. Firstly, it was thought that if a score were provided to participants upon completion of the Pre-Test, whether high or low scoring, the participants would ask for an explanation of the questions they did not get correct, and why. The reverse is also true, in that the participants may have wanted to know which question they answered correctly. As the Pre-Test and the Post-Test were the same, providing answers and feedback in the Pre-Test was considered counterproductive to the study, as regardless of whether an indication was made of correct or incorrect answers, the participants could still go into the Post-Test armed with knowledge not necessarily gained from the weekly learning materials. Participants were not informed that the Post-Test was the same as the Pre-Test. The second reason for not providing participants with the Pre-Test score was to prevent participants from becoming disillusioned with the process if they received a particularly poor score, an outcome that may have been unlikely, but was still considered a risk.

3.8.2 Post-Test Instruments

The Post-Test instrument was identical to the Pre-Test instrument in order to get a precise measurement of each participant's scoring performance difference between the two instruments, using the same metric, in order to increase the reliability of the data returned (Drew et al., 1996). Using a different set of questions on the Post-Test as opposed to the Pre-Test would have essentially moved the 'yardstick' against which the participants were measured, making it more difficult to ascertain performance differences. Were the questions easier, harder, relevant, the same but differently worded? To eliminate these issues, it was decided to keep the same questions in the same order. The second reason for retaining the same questions in the same order was to give a reference point for analysing the way in which participants attempted the two instruments. Did they get the same questions correct or incorrect on both instruments; did they change correct answers into incorrect answers or vice versa? Were questions left blank, and if so, were they left blank on both tests by the same participants? By analysing the manner in which participants attempted the two tests, a better understanding could be had as to whether the participants were actually answering questions they knew, or whether they were in fact guessing, or randomly selecting answers so as to complete the testing process.

As with the Pre-Test, the Post-Test recorded the start time and the completion time of the test, allowing for a measurement of time versus performance on the Post-Test in comparison to the time versus performance on the Pre-Test. The aim was to see not only if participants performed better on the Post-Test than on the Pre-Test, but if they took less time, the same time or more time to complete the Post-Test.

To summarise, the Pre-Test instrument was designed to create a baseline of participant's level of topic knowledge at the beginning of the week of study, measuring scores, given answers and completion times. The Post-Test was the same as the Pre-Test so that a direct comparison of scores, answers given and times for completion could be made using the same measure as used for the Pre-Test baseline. The differences in scores, answers and time for completion between the Pre and Post test instruments would give an indication of what each participant had gained from their weekly learning materials, regardless of whether they were in the control or treatment group. As well as individual performance differences, the differences between the Pre and Post test performances for the two groups would give an indication as to whether the CCS method of content delivery produced significantly different performance results as compared to the normal eLCMS delivered content.

As with the Pre-Test instrument, participants were not given their Post-Test score after completion of the instrument, primarily for the same reasons, in that it was felt some students might be disappointed or angry with their Pre/Post test scores, which in turn might have affected their response to the online student survey, which immediately followed the Post-Test instrument. On the other hand, it was also considered that the treatment group participants in particular, by not receiving their Pre/Post test scores, would have no frame of reference as to whether they had benefited from the CCS system or not. These participants would be forced to make their own intrinsic judgement as to what, if any, learning value they had received from the CCS system. Again, this was considered as a factor that may have overtly influenced participant responses to the online learning survey, thus in the end the scores were not presented following the Post-Test instrument. It was originally intended that the Pre and Post test scores would be provided to the student participants upon completion of the online learning survey, but due to time constraints this feature was not included in the final version of the integrated account (Appendix A) system used by the student participants. Participants were informed that they could contact the researcher for their Pre and Post test scores, which could be read from the database manually, but by the end of the semester in which the study was conducted, no student participants had taken up this offer.

3.8.3. Student Survey Instruments

The online learning survey instruments contained a common set of statements for both the control and treatment groups, with the treatment group having extra items added to their version of the survey in order to measure attitudes towards the CCS content delivery method as well as the eLCMS method. The common section of the online learning survey was designed to explore student perceptions of the eLCMS from the point of view of both groups, looking at how students utilised the materials within the system and what they considered the strong and weak points of the environment. As this research was originally developed from a concern that students were not using the learning resources within the eLCMS as effectively as possible, an understanding was sought of the actual student usage patterns of these materials. The student survey instruments, when combined with the basic eLCMS clickstream data and the more detailed CCS clickstream data were designed to illuminate how students actually worked with learning materials within the eLCMS and CCS systems versus how they actually wanted to work with the materials. The following sections discuss the control and treatment versions of the survey.

3.8.3.1 Common Survey Questions (both groups)

As the control group participants were only using the eLCMS and learning materials in their usual weekly format, a set of statements was developed against which participants could indicate how they used the eLCMS and the content contained within. The survey was divided into six sections (see "Appendix A – Instruments"), labelled;

1) Technology experience and access
2) E-Learning experience

3) eLCMS usage

4) Study practice

5) Three most preferred features of the eLCMS

6) Three least preferred features of the eLCMS

A bulk of the survey instrument was comprised of statements to which participants could respond on a Likert scale. The Likert scale values used were;

SA = Strongly Agree

A = Agree

N = Neither agree nor disagree

D = Disagree

SD = Strongly Disagree

NA = Not Applicable

As the surveys and the Pre-Test and Post-Test instruments had been designed to gather largely quantitative data, sections five and six of the survey were designed to gain qualitative responses from participants, with the view that some of the unstructured responses given by participants would re-enforce some of the responses provided to the more structured items seen in sections one through four.

3.8.3.1.1 Section one of student survey (both groups)

Table 3-1: Survey items for section one

1. Technology experience and access	
1.1	I am comfortable using computing technology
1.2	I classify myself as a competent user of computing technology
1.3	I mainly access the e-learning resources from
	-home
	-work
	-university
	-all equally

Section one (Table 3-1) of both surveys was designed to gather data as to how each participant viewed their own level of competence in the general area of computer usage. Though the participants were enrolled in a school dedicated to computer science and information technology, this was not seen as a guarantee that students in such an environment would necessarily be highly computer literate. Students could have been in their first year of study, or could have been enrolled in a computing unit, though actually be from a totally different field of study, such as one participant from a psychology degree. While the information from this section of the surveys was useful for setting a baseline for each participant's self observed computing skills from both groups, the data was envisaged as being more relevant to the data collected from the treatment group, as their overall interaction with the CCS system would be more extensive and involved than the control group's interaction with the eLCMS.

Numerical values were encoded into the various survey items to allow for easier translation and manipulation of results in terms of statistical analysis. Each of the scale items was encoded with a numerical value, starting at +2 for the SA response through to -3 for the NA response. The survey instruments included Likert scale, open-ended, partially open-ended and closed items. In item 1.3 each of the options had an encoded value, with *home* being +1 through to *all equally* being +4. The form option fields used to collect data in item 1.3 were designed to allow only one response, in order to make the participant choose the *most* appropriate of the four values. The *all equally* option was provided to cover those participants who did equally divide their study times between home, work and university.

3.8.3.1.2 Section two of student survey (both groups)

Table 3-2: Survey items for section two

2. E-Learning experience	
2.1	I classify myself as a competent user of the eLCMS
2.2	I am experienced at using online learning systems
2.3	Aside from the eLCMS, which of the following online learning systems have you used
	-WebCT
	-Blackboard
	-Other

Section two (Table 3-2) of the survey was similar to section one, focussing more specifically on each participant's background with e-learning and online learning environments. The overall goal of section two was to gain an understanding of each participant's perceived competency in using the eLCMS as well as any experience they may have had with other online learning environments. By asking participants about their use of other systems it was thought that they might contrast their experiences with those systems in gauging the features they liked and disliked regarding the eLCMS.

Items 2.1 and 2.2 asked participants to rate their level of agreement as to their own perceived competency with using the eLCMS, and whether they felt they were experienced at using online learning systems. These items were included to gain some background as to each participant's prior experiences with online learning, leading into the third question.

Item 2.3 was included as WebCT and Blackboard were employed at the university in question, meaning that some of the participants might have had cause to use either or both of those systems at some time during their studies. This item provides an example of a partially open-ended response as it allowed participants to select the *other* option and enter their own list of online learning systems, which would provide a profile of the participants experience with online course systems. Open-ended items allowed participants to write unstructured responses to the statements posed in sections five and six.

3.8.3.1.3 Section three of student survey (both groups)

Table 3-3: Survey items for section three

3. eLCMS usage	
3.1	I print then read the resources provided on the eLCMS
3.2	I read the resources provided in the eLCMS straight from the screen
3.3	I find I can get through my units only using the eLCMS rarely
3.4	Where an entire semesters worth of content is available at the beginning of semester, I download all materials and rarely refer back to the eLCMS

Section three (Table 3-3) of the survey was designed to determine how participants actually used the eLCMS to access their weekly learning materials.

Items 3.1 and 3.2 asked participants to indicate how they used the weekly learning materials placed on the eLCMS, whether they printed then read the materials or whether they read them directly from the screen. This information was sought for two reasons, the first being to gauge how the format of the materials within an online learning environment might affect student usage of those materials. HTML based materials are easy to read from the screen and are well suited to the WWW medium, but can be troublesome to download, store or print on local computers. PowerPoint files on the other hand do not display as readily within a WWW browser, but make for easy local document storage and printing, whilst PDF documents are ideal for both. The second reason regards the amount of time that students spent working with the materials directly, and online. Given the functionality of the CCS system it was expected that participants would need to spend more time working online, as the materials were divided into smaller, more discrete 'chunks' and delivered according to participant performance through the CCS specific assessments. If participants indicated that they did not like reading from materials on the screen and thus not spending an excess amount of time working directly online, the format of the materials placed in the CCS system or any system like it would have needed to accommodate such a usage model.

Item 3.3 was somewhat 'loaded' given anecdotal experience where students using eLCMS in other units were very quick to react to missing content or newly added content placed on the system. However, it was felt that the item needed to be included, to ascertain the 'norm' for participant usage of the eLCMS.

Item 3.4 was considered extremely important to the data gathered from both groups, but particularly the treatment group. This researcher and many other academic staff within the school had experienced the situation where students would begin sending questioning or complaining emails within the first few days, even the first few hours, of the commencement of semester if all 12-13 weeks of learning materials were not immediately available. In units that had been fully developed and run at least once before it was not unreasonable or uncommon to have an entire semester's worth of content available to students from the outset of the semester, though for units that were in-development at the beginning of the semester, having more than a few weeks of content available beyond each teaching week could be extremely difficult.

The use of the eLCMS over the last several years has apparently fostered an expectation in students that all materials for the semester, including example exams and exam review tips, should be available from the beginning of the semester. Issues that arose from this attitude were the tendency of some students to download everything at the beginning of semester, and then to only rarely refer back to the system afterwards, indicating again the gulf between online learning and online content delivery. This problem was compounded when students operating in this manner became aggrieved when materials that they had collected and printed, were changed later in the semester, as they frequently did. From a unit co-ordinator's point of view units tend to evolve each semester that they are taught, especially in the computing sciences where content requires regular updating to remain current and relevant.

3.8.3.1.4 Section four of student survey (both groups)

Table 3-4: Survey items for section four

4. Study practice	
4.1	My usual study practice is to work with the materials in the week presented
4.2	I complete all the weekly materials and activities in the week presented
4.3	I know how I learn best
4.4	I prefer to study at my own pace

Section four (Table 3-4) of the survey builds on section three by specifically asking participants to indicate how they actually worked with the content within the eLCMS, and not just how they used the eLCMS.

Item 4.1 asked participants to respond regarding how they worked with the materials in the week presented, while Item 4.2 regarded their completion of the materials in the week presented. These items were important to the study in order to identify student expectations that a bulk of a semester's learning content will be available at or near the beginning of semester. This is in contrast to the more traditional unit teaching methods employed only five or six years ago, when paper based materials were presented to students in the week they were taught, generally on the day they were taught.

Items 4.3 and 4.4 established how each participant saw their own ability to learn and to regulate their learning, creating a reference point for analysis compared to their actual scoring performances in the Pre/Post-Test instruments. Participants in the treatment group using the CCS had a large amount of data collected against their use of the system as well as their performance in their various assessment points. To this end it was important to establish how a student saw themself as a learner and user of online materials, versus how they actually used the systems and the content within them.

3.8.3.1.5 Section five of student survey (both groups)

Table 3-5: Survey items for section five

5. List three (3) features you like most about the eLCMS	
5.1	
5.2	
5.3	

Section five (Table 3-5) allowed participants to give open-ended responses listing their most favoured features of the eLCMS. Comments on content, frequency of access, structure, format of materials and usability were the responses that were sought, without actually specifying them to the participants.

3.8.3.1.6 Section six of student survey (both groups)

Table 3-6: Survey items for section six

5. List three (3) features you like least about the eLCMS	
6.1	
6.2	
6.3	

Section six (Table 3-6) allowed participants to give open-ended responses listing their least favoured features of the eLCMS. The comments sought in section six were the same as in section five, though from a negative rather than positive perspective.

3.8.3.2 Treatment Group Questions

The treatment group version of the online learning survey contained four adadditional sections specific to the CCS study, these sections being.

7) Controlled content sequencing

8) eLCMS and CCS comparisons

9) Three most preferred features of the CCS

10) Three least preferred features of the CCS

3.8.3.2.1 Section seven of student survey (treatment)

Table 3-7: Survey items for section seven

7. Controlled content sequencing	
7.1	I like the way in which the CCS materials were structured and sequenced
7.2	I found the structure provided by CCS to be helpful in my understanding and comprehension of the weekly materials
7.3	I feel that CCS worked well in conjunction with class-based learning activities
7.4	CCS would be better suited to a fully online mode of study
7.5	The requirement to work through materials rather than download the whole weeks content at once does not bother me
7.6	I felt more confident working on the weekly materials knowing I was doing the work in the correct order
7.7	I found the constant assessment (tests) / feedback feature to be useful in gauging my learning performance
7.8	Which of the following content types do you think are best suited to CCS
	-Lecture slides/notes
	-Readings
	-Workshop activities
	-Other

Section seven of the survey contained many of the core attitudinal measures in regards to how participants reacted to the CCS system.

Items 7.1 and 7.2 specifically asked participants about their opinions on the manner with which the CCS materials were sequenced and structured for delivery. As the literature in the previous chapter indicated, structuring and delivery of content can have an impact on how students comprehend and navigate content with an online or hypermedia environment. As significant time and effort was afforded to the structuring of the learning materials into the different sections or ‘subjects’ in the CCS system, it was considered important to ascertain whether participants actually perceived any value from this structuring.

Items 7.3 and 7.4 asked participants where they felt the CCS system would be most useful, as an adjunct to normal class based teaching, as it was used in this study, or as a delivery method aimed purely at online students. Most participants would have been aware of how online units operated as many students in the school enrolled in online versions of units where conflicts existed in a semesters teaching schedule, or because some units may have only been run in the online mode in some semesters. The media formats used for the content within the CCS system was designed so that the materials could be used in a fully online manner.

Item 7.5 focussed on the requirement for working linearly through a week's content rather than downloading it all at once and was designed to directly ascertain the student's attitude to this core aspect of the CCS approach. Participant responses to this item could be validated for a level of consistency by examining the responses provided to items 3.4, 4.1 and 4.2 from the common set of survey statements.

Item 7.6 was designed to capture data from participants with respect to following a set sequence of learning content, and whether such a prescribed sequence aided them in their learning confidence. The participants' responses to this item could again be compared to those given to item 4.3, where participants were asked how well they understood their own best learning practice.

Item 7.7 focussed purely on the assessment/quiz items that the participants were required to use throughout their interaction with the CCS system. While previous items had focussed on the structure and sequencing of the CCS materials, item 7.7 asked participants if they found the assessment/quiz items useful for assessing their own knowledge. This item was designed to be matched with the responses from items 4.3 and 7.6, testing to see whether a disparity existed between each participant's confidences in their own learning style versus confidence they may have gained from the constant self-assessment aspect of the CCS system.

Item 7.8 asked participants which type of content they felt the CCS system was most suitable for, with the three main options of lectures slides, readings and workshop activities being made available as well as an *other* option which allowed participants to specify content not included on the list.

3.8.3.2.2 Section eight of student survey (treatment)

Table 3-8: Survey items for section eight

8. eLCMS and CCS comparisons	
8.1	I prefer the usual eLCMS method of content structure and delivery
8.2	I feel a mixture of eLCMS and CCS content delivery methods would be beneficial
8.3	I prefer to download all the materials and work on them at my own pace and in the sequence I feel comfortable with
8.4	I would like to see a system like CCS used in my other units

Section eight of the survey was designed to directly ask participants about their attitudes towards the CCS system versus the eLCMS.

Item 8.1 presented the statement as to whether participants preferred the eLCMS system as the method of content delivery. This was perhaps one of the most direct statements put forward in either version of the survey instrument and was designed to be a definitive as possible.

Item 8.2 asked participants if they felt a mixture of the CCS and eLCMS systems would be beneficial. The responses to this item, when compared to participant responses to the first item in section eight were thought to give a true indication of how a participant felt about the CCS system at any level.

Item 8.3 was designed as a measure of consistency, essentially posing the same statement as in item 8.1, again being a variation on the combined themes of items 4.3 and 4.4.

Item 8.4 presented participants with the concept of using the CCS system for content delivery in their other units of study. While section seven presented statements that focussed on specific areas of content delivery and how the CCS system was used was to accomplish that task, section eight directed statements to participants for their preference between the eLCMS method of content delivery and the CCS method.

While section seven was designed to be indicative of the various elements of the CCS method, section eight was designed to be definitive.

3.8.3.2.3 Section nine of student survey (treatment)

Table 3-9: Survey items for section nine

9. List three (3) features you like most about CCS	
9.1	
9.2	
9.3	

Section nine was designed to allow participants to list the features they liked most about the CCS system (Table 3-9).

3.8.3.2.4 Section ten of student survey (treatment)

Table 3-10: Survey items for section ten

10. List three (3) features you like least about CCS	
10.1	
10.2	
10.3	

Section ten was designed to allow participants to list the features they liked least about the CCS system. (Table 3-10)

The final two sections of the treatment group version of the online learning survey were exactly the same as sections five and six of the common set of survey items, with the exception that the treatment group participants were asked to list the three features they liked most of about the CCS system and the three features they liked least. These open-ended items were placed at the end of the survey so that, having filled in sections seven and eight, participants might then reflect upon and re-enforce some of the responses they had provided in earlier sections of the survey instrument. As the study was designed to explore how participants used the CCS system as well as what they thought of it, positive or negative responses were more than welcome, particularly in they were specific in nature.

3.8.4. Clickstream Data Collection

Data recorded in the clickstream included log-in and log-out times and frequency, time spent on the Pre and Post test instruments, time spent on assessments within the CCS system, time spent on each piece of learning content within the CCS system and the overall number of clicks on each piece of learning content and its associated assessment. Given the comparatively small amount of clickstream data collected from the control group, this section will concentrate primarily on the CCS clickstream data recording mechanisms.

Log-in and log-out data was recorded in order to gain an understanding of the system access patterns used by participants in the treatment group. By recording log-in and log-out events and the times they took place, an analysis could be done on the number of times each participant accessed the CCS system before completing all the weekly learning materials, as well as the total time required to complete all the materials, measured from the first log-in to the CCS system to the last log-out after the final piece of learning material was completed.

While the system access data described the comings and goings of participants within the CCS system, the recorded clicks by participants on the individual learning content items and their associated assessment items provided the detail as to how participants worked with the system during each session. The clickstream logging system was designed to record the UserID of each participant, the ObjectID of the learning or assessment item that was being accessed, the actual event that was taking place and the date-time stamp of when the event occurred. During the development of the clickstream logging system consideration was given to how much or how little information should be recorded about each and every event in the system, and in the end, what data would be useful for the analysis of participant usage patterns. The following analysis chapter describes the nature of the basic eLCMS clickstream data and the more detailed CCS clickstream data.

3.8.5 CCS Assessment Scores

Assessments within the CCS system were used as barrier reinforcement tools to constantly assess a participant's performance in relation to the weekly learning materials, from which further access to the weekly learning content could be controlled. Online interactive assessments are well researched and widely used features of online learning environments (Pathak & Brusilovsky, 2002), and provide convenient and immediate data collection to which a system can react dynamically (Byers, 2001). Darbhamulla and Lawhead (2004a) used quiz (assessment) items in conjunction with clickstream data as a means of gauging student performance with a set of online learning materials, from which the flow and type of content could be re-defined on a student by student basis. Within this research the total assessment item scores for each section, combined with a recorded number of attempts for that section (Hansen, Salter, Simpson, & Davies, 1999), provided the decision point as to whether participants were required to re-attempt a section again or were allowed to proceed to the next section of content.

Stored separately to the clickstream data, but considered an integral part of the participant user data were the scores for each participant for the assessment items within the CCS system. Each section was comprised of four assessment items, one per lecture, reading and workshop item and one end of section review, giving 12 assessments overall. As participants worked through the CCS materials, both their score and a written grade for each assessment item was stored in the system as an attribute of their user account. As each assessment item was completed the CCS system changed the Completed flag (or attribute) for the assessment from 0 to 1, writing the assessment score over the top of the default score of zero, which was set automatically upon the creation of a new user account. The written grade was then updated from the default value of 'Pending' to 'Unsatisfactory', 'Pass' or 'Perfect Score' depending upon the participants performance within the assessment. This data allowed participants to see how far they had progressed through the CCS materials by looking at their scores for completed items, and the items that were visible but not available, indicating they were yet to be completed.

The assessment scores for each participant were designed to be integrated into the clickstream data analysis, so that scores for individual assessments, whole sections and the entire week's worth of CCS materials could be evaluated against the time taken on each, the number of clicks required on each and the number of log-in/log-out events that occurred during each. When combined with the clickstream data describing participant access times and number of clicks per learning item, an analysis could be performed as to the total amount of time and the total number of clicks required by a participant for the completion of a learning item/assessment set. When correlated with the returned score, analysis was able to be performed as to possible relationships between usage patterns associated with the learning/assessment items and actual participant performance.

A majority of the in-section assessment items for lectures, readings and workshops contained five questions, while the end of section review assessments contained seven. The questions used in each assessment were predominately closed in nature, such as true/false, yes/no and multiple choice selections. Some assessment items included open-ended question types that allowed participants to type answers into a text field within the form. As with the Pre and Post test instruments, each question in each assessment had a score value of one, with questions designed to be specific to the learning content, but not necessarily weighted or 'more difficult' as the sections progressed. However, given that the content within the three sections was structured according to a logical topic progression, the learning content from which the assessments were drawn did in fact increase in difficulty with each of the three sections.

For each open-ended question placed within the CCS assessments, several 'acceptable' answers were encoded into the system, taking into account different spelling, character spacing and capitalisation that could possibly be used by participants in their answer. As an example, a workshop assessment question asked participants to write a piece of form declaration code, to which several possible correct answers are available. A character limit was placed on each of the form text fields used by the participants to type in their answer, the limit being set to the longest version of the correct answer.

Participants were not made aware that there were multiple 'acceptable' answers for each of the open-ended questions, as it was hoped that, presented with a question requiring a specific answer, the participants would work through the associated learning materials in sufficient depth to locate the correct answer. As later chapters will show, several students either did not attempt to answer these types of questions, or entered answers that did not fit in the provided field. It was thought that the reason for participants' unwillingness to attempt the open-ended questions was that they felt the required level of precision was too high, and thus that it did not warrant the effort required. Chapters 5 and 6 indicate that this was indeed the case.

3.8.6 Staff Survey Instrument

The staff survey was designed to gain a perspective on how academic staff members within the university school used the eLCMS system, how it affected their teaching style, and what their reactions would be to the concept of the CCS system. The staff survey instrument was designed to be completely anonymous and required no user-specific accounts or groupings of participants, and in many areas was a staff-oriented version of the online learning survey presented to the student treatment group. The staff survey was delivered approximately two weeks after the completion of the data collection phase of the control/treatment group study.

Once the survey was created and placed on the research server, a blanket email (see "Appendix C – Recruitment and Communications") was sent to all members of academic staff within the school asking them to go to the online staff survey and complete it at their convenience. Like the treatment group online learning survey, the staff survey featured two main sections, the first relating to the eLCMS and their usage of it, while the second queried staff about their reactions to the concept of CCS system. In order to give the staff an idea about what the CCS system entailed, information was placed on the research server, with a link to these materials being placed in both the email to staff and at the top of the survey instrument itself. Staff members were also given an account created, as a student, within the CCS system so that they could see it in action before completing the staff survey instrument.

The preliminary section of the survey, Teaching Experience / Details, (Table 3-11) was designed to gain an understanding of each responding staff member's gender, primary area of teaching as well as previous and current teaching experience. This background information collected in order to place each respondent's data in perspective, as the teaching styles and behaviour of senior versus junior academic staff members could have had a bearing on the given responses.

Table 3-11: Staff demographic items

Teaching Experience / Details	
Primary teaching area (discipline)	
Number of years tertiary teaching experience	[1…..10+]
Number of units you are teaching this semester	[1…..5]
-how many are online only?	[1…..5]
-how many are on-campus only?	[1…..5]
-how many are mixed-mode?	[1…..5]
Gender	[M/F]

The question regarding the staff member's teaching load and mode of delivery was designed to establish the workload of each respondent, and subsequently how much exposure to the eLCMS system they might have had. The mode of delivery was specifically separated for two reasons, the first being that a large number of units across most of the courses offered in the school were available in a number of delivery modes, the second being that during the evolution of this study, several staff members had stated that the CCS sounded like 'just the thing' for structuring the delivery of their online units. It was hoped that such passing statements amongst staff members would translate into useful responses from staff in the latter half of the survey.

3.8.6.1 Section one of staff survey

Table 3-12: Survey items for section one

1. eLCMS teaching practice	
1.1	I have significant expertise in the online and e-learning field
1.2	I find I have had to change my teaching style to fit the eLCMS delivery method
1.3	Using eLCMS has reduced the time overhead of unit management
1.4	The features of eLCMS I use most heavily in my teaching include;
a	Unit forums
b	Unit messages
c	Links to external, web based content
d	Online document delivery
e	Online assessment submission
1.5	Which of the following online learning systems have you used
	-WebCT
	-Blackboard
	-Other
1.6	I usually place an entire semester worth of materials into eLCMS at the start of semester
1.7	I place materials into eLCMS on a week by week basis
1.8	I have had students complain to me early in the semester if all the semester materials are not available immediately

Section one (Table 3-12) of the staff survey was designed to ascertain both staff usage of the eLCMS as well as any previous experience with other online environments.

Item 1.1 asked staff to state their level of expertise in the area of online learning, primarily to set a measure against which the rest of the staff members responses could be analysed.

Item 1.2 was a statement as to whether the staff member had to change their teaching style to work with the eLCMS method. The changes envisaged as being relevant to staff included the pressure from students to have a bulk of the semester materials available early in the semester, and even a reduced emphasis on face to face teaching and interaction.

Item 1.3 sought staff response to whether the eLCMS assisted in reducing unit management overhead, as issues of time and workload tend to dictate staff attitude towards any new teaching practice or modality.

Item 1.4 listed the main features of the eLCMS and asked staff members to respond to each one according to how heavily they utilised that feature, using the same SA through NA Likert scale. The responses to this item were envisaged as providing a clearer picture of the most frequently used aspects of the eLCMS, which in turn might affect answers to the CCS section of the survey, as the feature set in that system was more minimalist, being a research level system.

Item 1.5 asked staff to indicate prior online learning environments they may have used before. Responses to this item could also be examined against the first question asking the staff member about their level of expertise in the field of online learning.

Item 1.6 asked staff members if they made an entire semester's worth of content available within the eLCMS at the beginning of semester. This was essentially a counter point to item presented to the student participants, asking if they downloaded an entire semester worth of content at the beginning of semester if it were available. This item was designed to gauge the difference in perspective between how staff members viewed the issue of placing teaching materials on the eLCMS versus the expectation of students within the study.

Item 1.7 was another that was drawn from the student survey instrument, in this case asking staff members to indicate their preference for placing content on the eLCMS one week at a time.

The responses provided to item 1.6 and 1.7 by the staff could be viewed against the answers provided in the CCS section of the survey in terms of consistency of attitude, from the perspective of staff possibly using the one week at a time content delivery method as their own form of content sequencing.

Item 1.8 was another that was designed to be compared to answers given by student participants from the control and treatment groups. The item asked if staff members had ever received complaints in units where all the semester materials were not available at the beginning of semester, while the student version of the item asked if they would download an entire semester worth of content if available. While anecdotal evidence within the school indicated that staff members had indeed received complaints about content availability at the beginning of semester, it was hoped that item eight would provide a real indication of such student behaviour

3.8.6.2 Section two of staff survey

Table 3-13: Survey items for section two

2. List three (3) features you like most about the eLCMS	
2.1	
2.2	
2.3	

Section two (Table 3-13) asked staff members for open-ended responses, listing their three most preferred features of the eLCMS.

3.8.6.3 Section three of staff survey

Table 3-14: Survey items for section three

3. List three (3) features you like least about the eLCMS	
3.1	
3.2	
3.3	

Section three (Table 3-14) sought open-ended responses to staff member's three least preferred features of the eLCMS.

3.8.6.4 Section four of staff survey

Table 3-15: Survey items for section four

4. Controlled content sequencing	
4.1	I would like to have students work on materials in an order I have determined
4.2	I feel that a mixture of the eLCMS delivery method (click what you like) and controlled content sequencing (following a controlled sequence) might be better than using only one or the other
4.3	I think students taking my units would react well to controlled content sequencing
4.4	I believe that the following mechanisms would be appropriate to control sequencing of course content;
a	quizzes / tests
b	number of attempts at tasks by a student
c	time spent on tasks by a student
d	displaying / hiding materials according to dates and times
e	interaction from a member of the teaching staff (such as a confirming that a student has placed a relevant message on a unit forum)
f	Other
4.5	I believe controlled sequencing;
a	would be better suited to units delivered in a purely online mode
b	-would be better suited to units delivered in a purely on campus mode
c	would work well in conjunction with my usual class based teaching activities (lectures/workshops)
d	would assist my students in their comprehension of the weekly topic(s)

Section four (Table 3-15) of the staff survey contained the CCS specific items, presented on the assumption that the participating staff members had read the provided CCS system design documents and logic behind the research project.

Item 4.1 asks staff members if they would like to control the sequence in which students study the weekly learning materials. This item was derived directly from item 8.3 in the student treatment group survey, where students were asked their preference for downloading and studying materials at their own pace and in the sequence of their own design. As the survey instruments for both student and staff participants were concerned with attitudes to both the eLCMS and CCS systems, it was felt that where possible a crossover of attitude data would be useful, such as items 4.1 in the staff survey and 8.3 in the treatment group survey. By constructing the survey instruments in this way, data could be collected from both staff and students as to their attitudes towards the CCS system. Data indicating a strong positive or negative response to common items posed to both staff and students were hoped to provide an accurate portrayal of the perceived usefulness of the CCS system, or elements of it, and where further work on the system was warranted.

Item 4.2 asked staff members if they felt that a combination of the eLCMS and CCS system might have been more appropriate, once again a re-development of a similar statement posed to the treatment group participants in their CCS section of the survey.

Item 4.3 asked staff if they felt their students would react well to the CCS system, and while obviously it would be difficult for staff to make an accurate prediction, it was felt that some interesting data could be derived from the responses given by staff to this statement when compared to the actual responses received from the student treatment group participants using the system.

Item 4.4 presented staff with a list of mechanisms that could be used within a CCS-based system to control the flow of course materials, including the use of quizzes, attempt limits, time limits and direct interventions from staff members. An *other* option was provided at the end of this list, allowing staff to define any control mechanisms they might deem useful in a CCS-like system.

Item 4.5 presented a list of scenarios to which the CCS system might be best suited, including online teaching only, campus based teaching only, or as an adjunct to normal lecture/workshop teaching, following a blended systems model. The final option within item 4.5 asked staff if they felt that the CCS system would be beneficial to students in comprehending their weekly learning materials. This was a fundamental statement in that a negative response from staff would indicate that the CCS was of no real value to their teaching method or style, and thus would more likely be a hindrance than a help to their ability to effectively teach unit content to students. This item was placed last on the list and within the CCS section of the survey so that it was in proximity to sections five and six (Tables 3-16 and 3-17), where once again staff were asked to give open-ended responses describing possible benefits and drawbacks of the CCS system.

3.8.6.5 Section five of staff survey

Table 3-16: Survey items for section five

5. List three (3) areas of your online teaching practice that could benefit from controlled content sequencing	
5.1	
5.2	
5.3	

3.8.6.6 Section six of staff survey

Table 3-17: Survey items for section six

6. List three (3) problems you could imagine arising from the use of controlled content sequencing in the delivery of online course materials	
6.1	
6.2	
6.3	

While the staff survey was designed to be complementary to the primary data collection mechanisms presented to the student participants in this study, it was considered essential as part of the triangulation of data instruments, being in the attitude section of the performance->usage->attitude structure. The counter point items in the staff survey, derived from those in the student surveys, were designed to both re-enforce and throw into contrast data from the student instruments.

3.9 Pilot Study

This section will detail the implementation of the pilot study of this research, including recruitment procedures for the student participants, formation of the two groups, communication with the students and the management of the student participants during the data collection process.

3.9.1 Pilot Study Context

The pilot study was designed for a unit that ran every semester and was a core unit across all the degrees offered within the school. The unit dealt specifically with computer security and covered the theoretical and practical aspects of storing, protecting and managing data and information on computer and network systems. The pilot study was conducted within this unit for the following reasons.

1) This researcher was not involved in the teaching or development of the unit, but was cognisant with the discipline area, allowing for the re-development of existing learning materials into a format compatible with the CCS objectives, that is, structured by topic and divided into smaller ‘chunks’. It was felt that by recruiting participants from a unit not taught and managed by this researcher, students would be more willing to be honest and forthright in their responses to the system.

2) The unit had a solid enrolment rate of approximately 120+ students per semester, allowing for a bigger population of students from which to recruit participants.

3) The materials in the unit were well suited to the objectives of the CCS system, with students being required to absorb large amounts of material, including lecture slides, readings, and research-based workshop activities. Each week of content already featured some basic quiz questions covering the week of content, creating a useful starting point for the assessment instruments used in the CCS system.

4) The unit co-ordinator was agreeable to the unit being used as a recruitment point for this study, and was happy to allow access to the unit teaching

materials for the development of the CCS materials, as well as proof-reading the content and assessments developed from the original unit materials.

3.9.2 Learning Materials

The unit co-ordinator in question was approached well before the beginning of semester and asked if he was happy to have his unit involved in the research, on the assurance that all ethical requirements of the university were duly met. As well as access to and assistance with the learning materials used for the study, the unit co-ordinator agreed to disable or 'hide' access to the week of learning materials in question before semester commenced, so that when the study commenced, all students, both in the treatment and control groups, would have a common starting point for the learning materials for that week. Given that the unit ran across two metropolitan campuses in semester one and had approximately 40 online (off-campus) enrolments, the unit co-ordinator agreed to hide the target week of content, though he would email the content to online students who specifically requested it. The unit co-ordinator also placed messages on the eLCMS explaining that the materials were inaccessible until the week in question, for the purposes of a research project.

The content chosen for the study was taken from week 12 of the unit, this material focussing specifically on Denial of Service (DoS) attacks on network systems. The content of the lecture materials and readings was quite technical, while the workshop activities were a combination of the type 'find out which of the following you would use in such and such a scenario' or 'list x number of consequences given a lack of proper network security'. Another reason for choosing week 12 of the semester for the study related to the fact that nearly all assignment submissions for any units the students might be enrolled in should have been completed, thus removing assignment work as a distraction from the target population. Being week 12 of semester, there would be only one week of teaching remaining, the unit review week, then a one week study break before the beginning of the two week exam period. It was hoped that by placing the study between assignment and exam study periods there would be a maximum likelihood of students wishing to participate in the study and actually completing all the data collection instruments.

3.9.2.1 Re-Authoring Learning Materials for CCS Integration

The original lecture materials contained slides covering the topic of DoS, with the three main areas of introduction to the concepts of DoS, how attacks are perpetrated using network tools and how attacks can be detected and defended against. In order to create a more scaffolded structure of the existing learning materials, the learning content for week 12 was re-authored into the following three 'subjects'.

1) Introduction to Denial of Service attack concepts
2) Denial of Service attacks - methods and types
3) Attack detection and prevention

The redesign of the original week 12 learning materials into CCS specific versions followed similar conversion techniques adopted by (Ainsworth & Grimshaw, 2002) in their research into the REDEEM system. While Ainsworth and Grimshaw (2002) referred to this process as authoring, in the context of this research it is more accurate to refer to the alteration of existing materials as re-authoring. These three sections or 'subjects' were considered suitable topic containers for the lecture materials, readings and workshop activities for the learning materials in week 12 (see Figure 3-5).

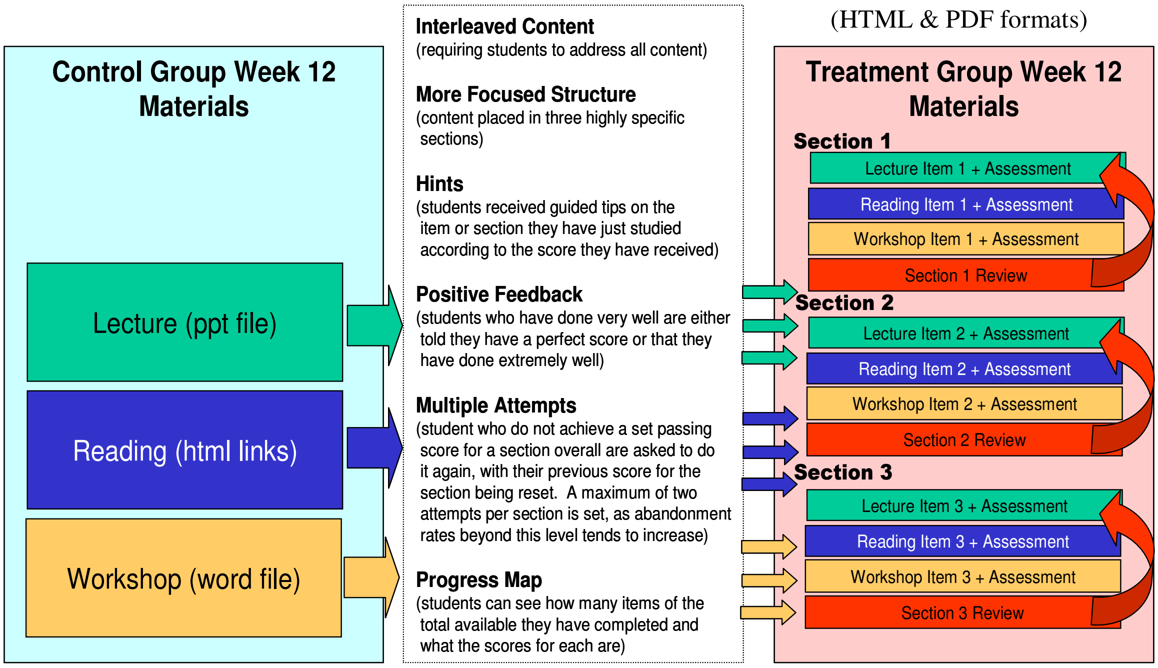


Figure 3-5: Re-authoring of week 12 materials

The lecture slides were converted from their original Microsoft PowerPoint™ format to HTML pages using the PowerPoint save as web page option. This created a HTML file with a large number of associated HTML files which worked together to render a WWW-based slideshow representation of the original slides. These HTML lecture slides were loaded into the main viewing frame upon students clicking the link to the lecture materials in the CCS system navigation frame. Though the readings for week 12 were entirely WWW based, it was decided to save the readings as HTML files and place them on the CCS system server, to avoid any problems of the readings not being available at the original locations during the week of the study.

The perceived advantage of using the HTML based versions of the lecture slides and the readings was that they both contained their own internal navigation systems, the lecture slides having this feature added by PowerPoint during the save process and the readings file because the they were already in HTML format and used internal HTML anchored links to move quickly from section to section of the document. In the case of the workshop activity files, the original Microsoft Word documents were converted to Portable Document Format (PDF) and once again loaded into the main viewing frame (see “Appendix A – Systems”).

It was thought that the format of these files, particularly the lecture and reading files with their native WWW format and internal navigation, would prove to be popular with the student participants in the study. As it turned out, these media formats were not popular with the participants in the pilot study and were abandoned for the main study. Discussion of the perceived problems with the WWW based media will be addressed in the outcomes section of the pilot study.

3.9.3 Recruitment Procedure

Three weeks prior to the targeted week 12 data collection period this researcher was invited to the lecture for the computer security unit by the unit co-ordinator in order to introduce the project to the student population. The Research Project Student Information Sheet and the Research Project Student Participation Form (see “Appendix C – Recruitment and Communications”) were integrated into a single three page document, with approximately 120 copies being produced and taken to the lecture theatre. After an introduction by the unit co-ordinator, this researcher spent approximately 10-15 minutes detailing the research study and the general aims of the research, focussing on the crucial nature of student input and participation. The copied research information and participation details were passed around the lecture so that students could read the specifics, and then if they were interested in participating, could sign and date the participation form and return it to this researcher or the unit co-ordinator. The information and participation forms were also presented to the students on the other campus by the unit co-ordinator, and were given to the workshop tutors in the unit to try and capture students in the workshops who had not attended either of the lectures. Finally, a PDF copy of the forms were placed on the eLCMS with a broadcast email message sent to all enrolled students, including online students, asking that they consider participating in the project. For those studying the unit online and away from the metropolitan campuses, a fax number was provided on the forms so that the students could print them, sign and date them and the fax them to this researcher.

The unit co-ordinator and tutors repeated this process on the week following the initial recruitment, in an attempt to gain participation from students who might not have attended classes the previous week. Five days before the beginning of the study, 29 students of the total population of over 100 students had filled in and returned their participation forms, with all 29 participants coming from the local campus and no students from the online group. It had been hoped that at least 40 to 50 participants would be involved in the study, but after further canvassing of the unit population, the number of participants did not increase.

3.9.4 Participants

Of the 29 participants to begin the pilot study, 24 were male and five were female. The average age of the male students was 27, while the average age of the female participants was 23. Of the 24 male students, three were enrolled in the postgraduate version of the unit. The courses in which the participants were enrolled were quite varied and included computer science, communications and information technology, software engineering, computer security, internet computing and one student studying psychology.

Email messages (see “Appendix C – Recruitment and Communications”) were sent to the 29 participants thanking them for their involvement and informing them of their group assignment (treatment or control) and the necessary steps and processes for completing the study. The tone of the emails was designed to be casual and friendly, with an emphasis on again thanking the students for their participation, and asking that they complete all elements of the research.

3.9.4.1 Group Assignment

Of the 29 participants, 15 would comprise the treatment group and 14 the control group. Each student participation form was labelled with a number, in the range of one through 29. A random number generator script was written that would generate 15 individual values in the range one through 29, with each number going through one million randomisation loops before being selected. The 15 returned numbers were used to select the treatment group participants from the participation forms, with the remaining 14 forms making up the control group participants. Issues of age and gender balance were not considered when deciding upon a process for the creation of the control and treatment groups, given that a large proportion of the participants were male participants in their early to mid twenties. As a result of the random assignment method, three female students ended up in the control group while the remaining two female participants in the study were placed within the treatment group. Of the three postgraduate level participants, two were randomly assigned to the control group and one to the treatment group.

3.9.5 Pilot Study Outcomes

Of the 29 participants who began the pilot study, 15 in the treatment and 14 in the control group, only four treatment and three control group participants completed all the data collection instruments. There were any number of possible reasons for this low completion rate, including this researcher's lack of proximity to the unit in question, the time of semester (students could have been tired or distracted), a lack of interest or a lack of motivation as, in the end, it was added work. While the pilot study was designed to test the CCS system and the data collection methods, it was hoped that some useful data would be returned that would allow for initial analysis and refinement of the analysis technique. However, the low number of completions made for very little workable data from an analysis standpoint, especially for making assertions as to trends in participant use of the CCS system, their attitudes to the system and what, if any, performance difference existed between the control and treatment groups. From a system analysis perspective the pilot study had a significant impact on the success of the main study in collecting useable data, including data that was not captured in the pilot study.

Informal feedback from some of the participants, through emails and corridor conversations rather than through the survey instrument, indicated that participants in the treatment group were not happy with the HTML based lecture and reading files. Apparently the participants wanted to be able to both download the files to their local computer and then print them, both of these tasks being difficult to complete with HTML files due to the way the WWW browser saved the files to the local system and how it rendered the files for printing. There were no complaints about the PDF documents, and as such it was decided that the ability to easily download and print the integrated PDF documents was more desirable from a participant perspective.

The pilot study also proved to be extremely valuable in identifying omissions and problems in the data collection method, the management of the participants in both groups in regards to completing the data collection instruments and in the recruitment procedure.

3.10 Main Study

After analysing the results of the performance of the CCS system and research instruments from the pilot study, work began on re-designing the study for use in a different unit in a different semester. While the pilot study was conducted at the end of semester one, the main study would take place early in semester two, providing approximately 10 weeks for the changes from the pilot study to be integrated into the main study.

3.10.1 Changes Resulting From Pilot Study

As a result of the outcomes of the pilot study, six primary changes were identified as requiring revision before the main study could commence. These six items related to the recruitment procedure, the management of the participants whilst within the study period, the collection of clickstream data and the alteration of the learning materials within the CCS system. The changes identified were;

1) The main study should take place within a unit authored and taught by the researcher so that the researcher could be in constant contact with the participants and have complete control of the recruitment procedure and unit content.

2) An incentive would be offered in the hopes of gaining higher levels of participation and data instrument completion.

3) That the eLCMS system needed to be integrated into the study to a greater extent, including controlled access through an integrated account system for the purpose of recording basic eLCMS clickstream data.

4) That the main study should be conducted earlier in the semester, while enrolments were at the high point of the semester, but well before the first assignment was due.

5) That more clickstream data was required, including Pre and Post test submission times and online learning survey submission times. First and second attempt scores for each assessment item in each section of the CCS system were required, as these were not included in the pilot version of the CCS system. All answers given in first and second attempts at all assessments were also recorded for the purposes of comparison, data that was not included in the pilot version of the CCS system.

6) The media format for the materials within the CCS system should be as the HTML based files proved problematic for participants.

3.10.2 Main Study Context

The main study was designed to be conducted within a second year, second semester unit focussing on WWW applications development, where students were taught client and server side WWW applications development, including database integration, data validation, online security and interface development. The unit in question had strong theoretical content in the form of lectures and readings regarding WWW protocols, numbering systems, project management, systems development and modelling and a heavy reliance on workshop based, hands-on coding exercises. The content of the unit was designed to take students from basic WWW pages to operational applications in 12-13 weeks. This unit was selected for the main study for the following reasons.

1) After the experience in the pilot study of not having constant access to the student population from which the study participants were drawn, it was decided to run the main study in a unit taught by this researcher. This would allow constant access to the students, informing them from the beginning of semester of the upcoming research and how it would be conducted. Essentially, by conducting the main study in a unit taught by this researcher, the highest possible level of proximity to the student population would be possible. Having full control of the semesters learning materials and schedule made for easier management of the conditions of the study overall.

2) The unit had a suitable enrolment rate, being a core unit across two degrees offered in the school. The initial enrolment rate was approximately 80+ across two campuses for second semester, though at the time of the study the unit was not offered in an online mode.

3) As with the pilot study, the learning content and materials for the WWW programming unit were well suited to the goals of the CCS system, featuring lecture slides, reading links and workshop activities. The unit was heavily reliant on two textbooks, students being required to read selected chapters from these texts on a weekly basis, relating to both the lecture materials and the workshop activities.

4) Given the technical nature of the unit and the amount of work required of students to successfully complete the unit, lecture and workshop participation were usually quite high, as was overall participation in the unit by the enrolled students. Those who regularly missed lectures and workshops found it extremely difficult to get up to speed with the materials afterwards, particularly come assignment time. It was hoped that this level of participation would transfer into those who agreed to take part in the study, leading to higher completion rates than those experienced in the pilot study.

As with the pilot study, the learning materials for the week the study was to run, week three, were hidden in the eLCMS from the beginning of semester. Students in the unit were informed via email, the eLCMS message system, and the unit forums and of course, in lecture and workshop classes for the reason behind week three missing from the schedule.

3.10.3 Learning Materials

Week three of the WWW programming unit focussed on examining the Internet Protocol (IP), IP numbering systems and the use of HTML forms for client-side data collection. The protocols discussion formed the basis of the lecture and reading materials for week three, while the HTML forms were covered in the workshop activities. The first assessment for the WWW programming unit was not due in until the end of week seven, allowing ample time for students to participate in the research study without being disadvantaged as to access to the week three learning materials before and during the week three data collection period.

3.10.3.1 Re-Authoring Learning Materials for CCS Integration

The original lecture materials for week three of the WWW programming unit consisted of lecture slides covering the workings of internet protocols, the exchange and communication of information, the individual components of protocols and the primary protocols used as a foundation for the internet. Internet numbering systems were covered, including how the Internet Protocol (IP) works in conjunction with the Transmission Control Protocol (TCP) to create the commonly combined protocol name of TCP/IP. Domain naming systems were examined from the point of view of how IP numbering is used to logically and physically segment sections of the internet, allowing for governments, corporations, educational institutions and individuals to have their own 'piece' of the internet.. As well as the slides covering these topics, three online readings were provided, going into explicit detail on the topics of IP numbering and domain methodologies. The practical elements of the week three materials were covered in the workshop activities, comprising a set of instructions that took students through the process and logic of creating an advanced HTML form, including JavaScript form validation. As with the pilot study, the week three materials were divided up into three highly focussed sections for use in the CCS system (see Figure 3-6).

1) Introduction to communications protocols

2) Internetworking and connectivity

3) Domains and IP numbering systems

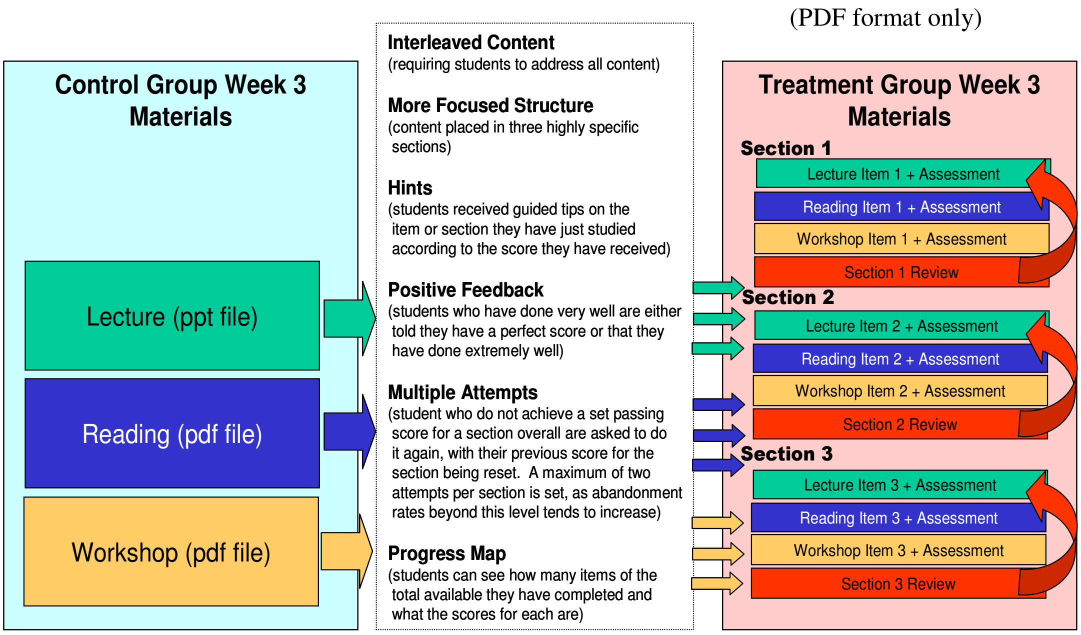


Figure 3-6: Re-authored week 3 materials

The lecture slides were broken into three separate PDF files, the first covering an introduction to communications protocols, with the addition of a slide that asked participants to attempt the associated CCS assessment, but not before ensuring that they had worked through the lecture materials. The addition of this extra slide prompting the participant to complete the work was designed as a further reinforcement of the need for the participant to interact as fully with the learning materials as possible. The second set of lecture slides were placed in a PDF document covering internetworking and connectivity, with the same reminder to participants to complete the associated assessment after reading all the slides. The final set of lecture slides covered domains and IP numbering systems, with the addition of the required textbooks readings for week three.

As discussed, the PDF file format was used for the lecture slides in the main study in place of the HTML format used in the pilot study, addressing the issues raised by some of the participants in the original study about the inflexibility of the HTML format for downloading and printing. The other benefit of using the PDF format was that the original formatting and colour scheme of the lecture slides was retained, so that participants saw the same slides in the CCS system as they saw in the weekly in-class lecture.

In order to convert the online readings to PDF format, the sites were loaded into a WWW browser then printed directly to a named PDF file. As the file contained exactly the same formatting as the original website as well as the address information, participants could go to the WWW sites and peruse the HTML links contained within the documents. In fact, the conversion of the sites to PDF worked so well for the CCS system that the links within the eLCMS to the online readings were replaced with renamed versions of the CCS readings. This was also done in order to aid in the added clickstream data collected from the control group in the main study, data that was not collected in the pilot study.

As with the pilot study, the workshop activities were originally Microsoft Word documents that had been converted to PDF. The eLCMS workshop file contained six exercises that covered the process of designing and implementing a HTML form with JavaScript validation for the form fields. For the purposes of the CCS system, the original document was restructured as three PDF documents containing two exercises per document, those being;

Workshop file one: Creating and formatting forms

Workshop file two: Checkboxes, text-areas, drop-lists, submitting forms using POST and GET methods

Workshop three: Adding JavaScript form validation to form fields

The use of the PDF format for the lecture, reading and workshop files made management of the documents slightly easier as there was only one file per learning item to manage, rather than a single index file and large number of associated visual and layout files as with the previous HTML versions. The PDF documents worked well with the CCS system interface as they loaded correctly into the main viewing frame rather than being prompted for download as they would be in the original PowerPoint or Word document formats.

3.10.4 Recruitment Procedure

The recruitment procedure for the main study was similar to the pilot study from the point of view that recruitment took place primarily in the lecture class, and to a lesser degree in the workshop classes. Students were informed of the research study in week one of semester, and were told that the research description and participant consent forms would be distributed to the class at the beginning of the lectures and workshops in week two. Students were informed that the week three materials on the eLCMS were unavailable and would remain so until after the study, a significant difference from the approach used in the pilot study. In the pilot study, after the control group participants filled in their Pre-Test instruments they were simply asked to go off and use the eLCMS as they normally would and return to complete the Post-Test instrument once they had finished with the weekly learning materials.

It was thought that this process might have originally contributed to the poor completion rates in the pilot study in that the control group participants had to remember to come back to the research website in order to complete the Post-Test instrument, and thus many probably forgot or simply never returned. In the main study, the eLCMS system was replicated and placed on the same research server, upon which the CCS system resided, allowing only participants in the control group to see the week three learning materials on the eLCMS, and the participants in the treatment group to see the CCS materials. Access to the eLCMS system was grouped in with the other research instruments, including the Pre and Post test instruments and the online learning survey. Though the version of the eLCMS running on the research server looked and worked exactly the same as the normal eLCMS system, it recorded clickstream data about the log-ins/outs and content access patterns of the participants within the control group.

During the recruitment phase in weeks one and two of semester, students in the unit were made aware of the restricted access to the eLCMS, and informed that should they wish not to participate in the research, they could send this researcher an email, after which they would be sent the week three learning materials. In the end, no students elected to have the content emailed to them, and those who did not wish to participate simply waited for the research study to be completed and for the normal week three materials to be made available on the eLCMS. At the beginning of week two the research description and participation consent forms were handed out in the lecture and workshop classes, with students once again being given an explanation regarding the research and how it was being conducted. Students were informed that they would be randomly assigned to the control or treatment group, and subsequently what would be required of them within each of these groups. Students were informed that though demographic and contact details were collected as a part of the study, the actual results of the study would be completely anonymous and that their performance within the study would have absolutely no effect on their studies within the unit. Students were also assured that should they wish to withdraw from the study at any time, they could do so without explanation. As a result of the low completion rate in the pilot study, an incentive was offered to all participants in the study, in the form of a free movie ticket. The students were informed that everyone who participated was entitled to a complimentary movie ticket as thanks for their participation, whether they completed the study or not, and that tickets would be made available at the conclusion of the study period.

As with the pilot study, PDF copies of the recruitment forms were placed on the eLCMS for students to downloaded should they be unable to attend class during the recruitment period. The students were informed in the lecture, workshops and via email that once the groups had been arranged and all participants identified, emails would be sent out with specific details of how to use the research instruments and either the eLCMS or CCS systems depending upon which group each student was randomly assigned. This email also contained account information and 24 hour contact details for the researcher should they run into problems with their respective systems.

3.10.5 Participants

Of a total enrolled population of 83 students across two metropolitan campuses, 76 elected to participate in the study, which was a 91% response rate, compared to the approximate 24% response rate of the pilot study. Of those 76 participants, 62 were male and 14 were female, with the male participants having an average age of 24 years, whilst the female participants had an average age of 29 years. A majority of the participants were undergraduate students, making up 70 of the participants, with the remaining six participants being enrolled in the graduate level version of the unit. As with the pilot study, students were enrolled in a wide variety of degrees including computer science, communications and information technology, software engineering, computer security, digital media, internet computing and one student studying a somewhat unusual combination of a bachelor of business double major incorporating software engineering and tourism management.

3.10.5.1 Group Assignment

The same random allocation procedure for group assignment as used in the pilot study was re-used in the main study. Once again, neither age nor gender were factors in the creation of the groups, the participation forms were simply shuffled, labelled 1-76, and divided into control and treatment group piles according to the randomly generated numbers. As a result of the random assignment, seven of the female participants were assigned to the treatment group with the remaining seven being placed in the control group. Of the six postgraduate level participants, two were randomly assigned to the treatment group with the remaining four going to the control group.

As with the pilot study, participants in both groups received emails indicating which group they had been assigned to, where and when they could access their respective systems, and what their account details were in order to do so. Again, the tone of the emails was appreciative for their efforts, and reassuring in that they could contact the researcher at any time should they have problems with the systems or concerns regarding the research.

3.11 Outcomes of the Main Study

The outcomes of the main study were that a suitable amount of data was collected from the control, treatment and staff user groups to enable meaningful data analysis. Of the original 76 student participants, 24 control group participants and 19 treatment group participants completed all the data collection instruments, which translated to a 63% completion rate for the control group and a 50% completion rate for the treatment group. The data from one treatment group participant who completed all items was excluded on the basis that the student 'experimented' with the CCS system, leading to convoluted clickstream data being collected against this participant's account. Though the CCS system was designed to take into account a certain amount of participant 'tinkering', it was always going to be difficult to make the system robust enough to deter advanced users with WWW development skills from using the system incorrectly, especially given the link driven interface (an issue related to using the GET rather than POST HTML form method). The total time required to get these completions took more than the allotted one week, with the study being extended to two full weeks.

Of the 33 staff members who received an email asking for participation in the staff survey, 12 staff members responded, which translated to a 36% response rate. The staff survey went out approximately two weeks after the beginning of the main CCS study, which would have placed it in approximately week five of semester, the point at which some units had their first assignments due, and when students were seeking the most amount of assignment assistance from staff. It may be that this contributed to the final staff response rate. It should be noted that though fewer staff responded than was expected, the depth and clarity of response made the staff data extremely useful.

The use of fully online instruments, in the Pre and Post tests, clickstream data and online surveys proved to be an efficient and practical way of collecting data from all the participant groups. It allowed the student and staff participants to complete all their instruments from whatever computer they were sitting on, without having to receive and send files. As discussed previously, the introduction and reliance upon systems like the eLCMS have created an expectation that most learning activities can be completed in a fully online manner, and that the more steps that are introduced into a process that takes the user away from the online environment, the less likely they are to complete all the steps of said process. By placing all the data collection instruments online, aside from the student participant recruitment forms, convenience was afforded to the participants, convenience that was designed to assist completion levels. The online data collection methods, where data from participants was constantly being fed into the research server database systems was also beneficial from a research monitoring perspective, allowing this researcher to write a number of researcher-only administration scripts that monitored completions in both groups, live clickstream data from both groups and to have direct access to the incoming data for each participant within the system. As the CCS system was managed via a series of scripted WWW pages, if participants had trouble with their accounts or a new test account was needed, all such management activities could be done via an admin-only interface from any WWW connected computer.

Though the pilot study returned no usable data, it did prove to be extremely important in identifying problems with the control and treatment group data collection methods, and illustrated the need for the highest possible level of proximity between the research participants and the researcher. Though an incentive was introduced into the main study, overall it proved to have little effect, as less than 20% of participants elected to collect their ‘free’ movie ticket, even after many reminders throughout the remainder of the semester. Anecdotally, several students commented to this researcher that the only real incentive that could be offered to make everyone participate was to make the study part of an assessment that contributed to the overall semester passing marks for the unit (a tactic that was incompatible with university ethics requirements).

It would seem that, for the students in the study unit at least, unit completion and good grades took precedence over any financial or material incentives, not unlike the views expressed by Schank (2002) in the previous chapter.

Overall, the main study ran smoothly and retuned ample data for analysis, with the data being stored in a format allowing for rapid translation to spreadsheets and other data manipulation tools. The analysis and use of the returned data from the student and staff participants is examined in detail in the following chapters.

Chapter 4

4.0 Performance and System Usage

This study used a two group experiment (control and treatment) in order to compare student learning performance, system usage and attitutudes towards using the eLCMS and CCS systems. This chapter examines the scores (performance) returned by the Pre and Post test instruments as well as the clickstream data (usage) from both groups in order to gauge the comparative performance of the two groups before and after using their respective online content delivery systems. The second part of this chapter examines how the control and treatment groups used their respective content delivery systems, including variables such as completion times, login events and materials downloads. CCS specific data recorded in the clickstream is also addressed, with a focus on the manner in which participants in the treatment group interacted with their learning materials.

The data and analysis presented in this chapter addresses the first supporting research question;

Supporting question one

"Is there a measurable difference in student learning performance between those using Controlled Content Sequencing (CCS) and those that do not?"

4.1 Pre and Post Test Comparisons

Only those participants who completed all the data collection instruments in their respective groups were included. The Pre and Post test instruments were completed by the 24 participants from the control group and the 19 participants from the treatment group. Variables such as test completion time, age and gender were examined to identify possible influences on the control and treatment group performances. Figures 4-1 and 4-2 show the scores for the Pre and Post tests, both showing an approximate normal distribution.

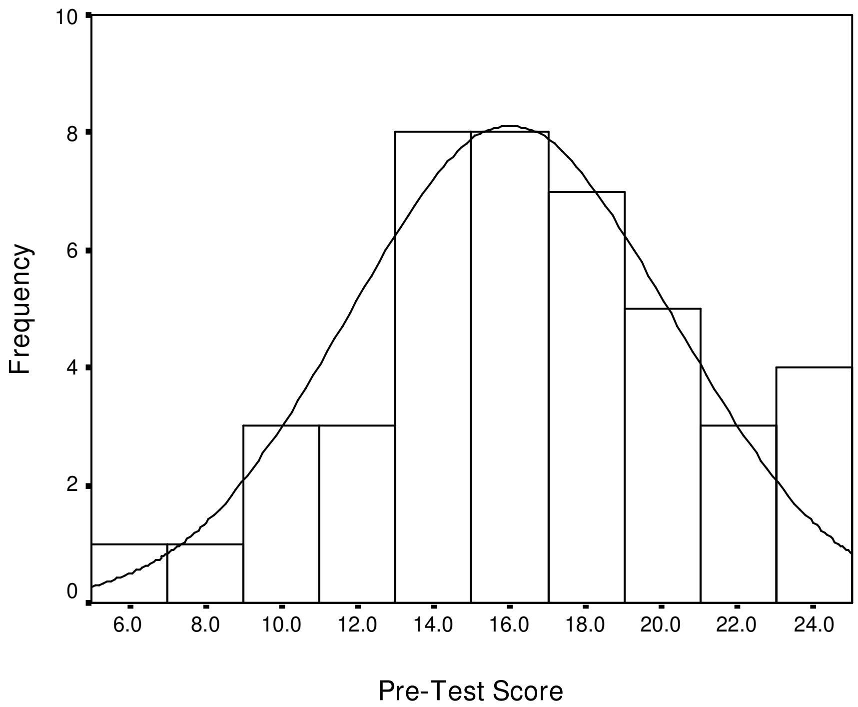


Figure 4-1: Scores in Pre-Test (combined groups)

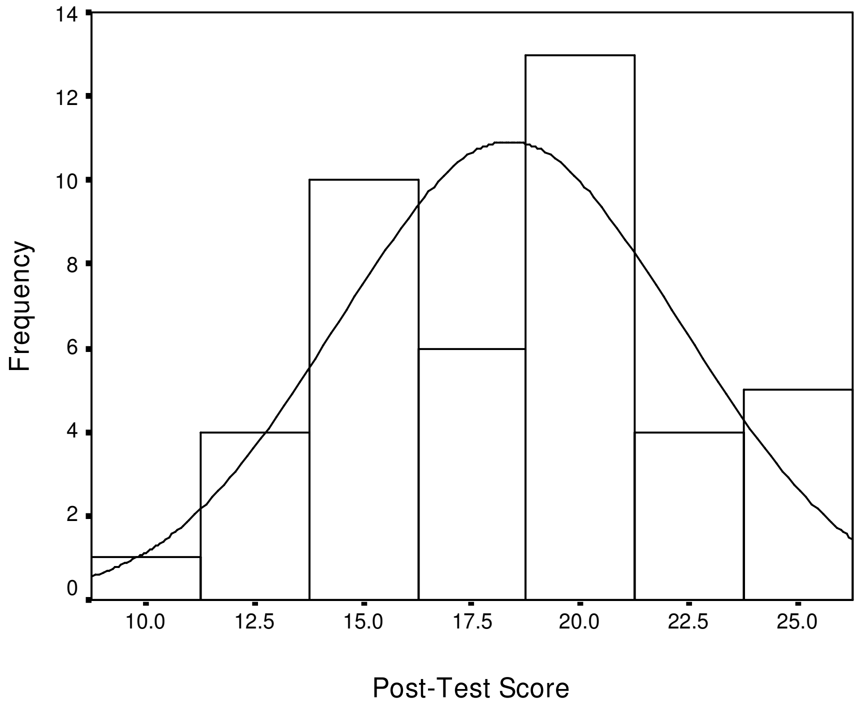


Figure 4-2: Scores in Post-Test (combined groups)

4.1.1 Performance by Group

Figure 4-3 shows the mean Pre and Post test scores of the control and treatment groups, showing that the treatment group performed better than the control group on the initial Pre-Test, and then went on to perform significantly better on the Post-Test. A repeated measures ANOVA test showed a significant main effect of time ($p<0.01$), indicating a significant performance increase for all participants in the study regardless of treatment group. This result indicates that at some time between sitting the Pre and Post tests, the participants in the study increased their level of topic knowledge to a point where it had a significant impact on their Post-Test performance.

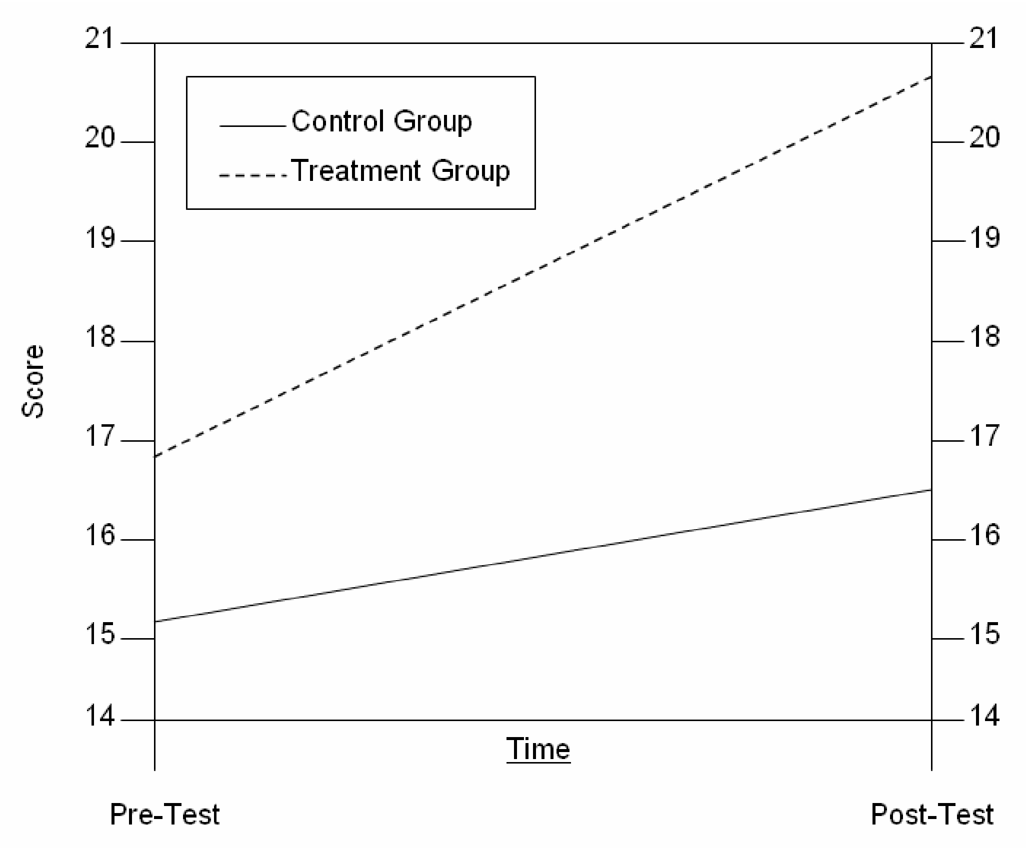


Figure 4-3: Pre and Post test performance for control and treatment groups

Table 4-1 shows the treatment group performed better in both tests than the control group, with a gap opening between the two groups in the Post-Test. The maximum and minimum score values show the treatment group improved in terms of both high and low scores between the tests, while the control group showed a higher minimum score value, indicating that even the poor students improved.

Table 4-1: Mean, max and min Pre and Post test scores by group (out of 30)

	Pre-Test			Post-Test		
	Mean (SD)	Max	Min	Mean (SD)	Max	Min
Control Group	15 (5)	23	6	17 (4)	24	10
Treatment Group	17 (3)	23	11	21 (3)	26	15

Looking at the between group factor (the control eLCMS or experimental CSS system), participants in the treatment group performed significantly better than participants in the control group (p=0.01). The interaction between time and experimental grouping was also significant (p=0.028), indicating that usage of the respective content delivery systems did influence the final performance score during the study period. In other words, those participants using CCS out performed those using the eLCMS to a statistically significant extent.

4.1.2 Performance by Gender

Table 4-2 shows the Pre and Post test scores by gender. It appeared that the males in both groups performed better on the two tests than the female participants, while the females in the treatment group showed more improvement between the tests than females from the control group. However, a repeated measures ANOVA test showed no significant effects of gender. It is suggested that the disparate size of the male/female population for both groups precluded uncovering a possible effect.

Table 4-2: Mean (SD) Pre and Post test scores by gender

	Pre-Test		Post-Test	
	Male	Female	Male	Female
Control Group	16 (5)	13 (5)	17 (4)	16 (3)
Treatment Group	17 (4)	16 (3)	21 (3)	20 (3)

4.1.3 Performance by Completion Time

This section examines the amount of time taken for the participants in each group to complete their Pre and Post test, and what, if any, role time played in each participant's performance. Table 4-3 shows the mean completion times in minutes for the two groups, including the respective minimum and maximum times.

Table 4-3: Pre and post test completion times (in minutes) for both groups

	Pre-Test			Post-Test		
	Mean (SD)	Max	Min	Mean (SD)	Max	Min
Control Group	12 (4)	21	5	10 (9)	38	0
Treatment Group	13 (8)	29	4	8 (5)	24	2

The mean completion times in minutes for the two groups in the Pre-Test was almost identical, although the treatment group did show a relatively large standard deviation due to the difference between the maximum and minimum completion times

(Table 4-3). Whilst the minimum time spent working on the Pre-Test was similar between both groups, the treatment group had a much higher maximum time, some eight minutes longer than for the control group. In the Post-Test the mean completion times for both groups fell, as did the minimum completion times. It was a member of the control group who returned the highest completion time of 38 minutes. A series of Spearman's correlations were conducted for all participants between scores and completion times for both Pre and Post test data. The results showed no significant influence of test completion time on test scores.

The amount of time that each participant was deemed to be 'working' with the content in either the eLCMS or CCS system was also examined. The term 'working' is highlighted here to illustrate that fact that it is difficult, if not impossible to gauge exactly what student participants were doing during this period, especially the control group participants due to the different access model used in the eLCMS (everything downloadable at once). For the purposes of this study it is assumed that participants from both groups, including the control group, were interacting with their respective learning materials, even when not logged into the respective systems. Using the clickstream data, discussed in greater detail in the following sections, this working time was calculated from the first time a participant logged into their content delivery system up and until the time they commenced the Post-Test instrument. Originally, this data was calculated in units of days, hours, minutes and seconds, but for greater fidelity in this particular analysis, was converted to hours. Thus, a participant taking 3 days and 8 hours to complete the learning materials returned a Weekly Learning Material Completion Time (WLMCT) score of 80 hours (3 x 24 + 8). A repeated measures ANOVA test revealed that the interaction between the WLMCT factor and time was significant (p=0.044), indicating that the longer a participant was 'working' with the learning materials in their given content delivery system, the better their subsequent performance in the Post-Test.

4.2 Participant Answers to Pre and Post Test Questions

While the previous sections showed the influences of group, gender and time on participant performances within and between the Pre and Post test instruments, the following data examines how the two groups approached the test instruments on a question by question basis. How each group answered the 30 questions in the Pre-Test were compared with the way those same 30 questions were answered in the Post-Test (Table 4-4).

Table 4-4: Pre-Test and Post-Test answer data for control and treatment groups

	Control Mean (SD)	**Treatment** Mean (SD)
Questions Answered Differently From Pre to Post Test	11 (6)	11 (4)
Incorrect on Pre to Correct on Post	5 (3)	7 (3)
Correct on Pre to Incorrect on Post	3 (2)	3 (2)
Correct on Pre to Correct on Post	12 (5)	14 (4)
Incorrect on Pre to Incorrect on Post	10 (3)	6 (2)

The first row within Table 4-4 shows that on average, participants within the control group answered 11 questions differently between the Pre and Post tests. One control group participant returned the highest difference value of 27 questions answered differently, while a minimum difference of only three questions was recorded for three other participants. The treatment group changed the same number of questions between the Pre and Post tests as the control group, with a slightly lower standard deviation.

The second row of Table 4-4 shows the mean number of incorrect answers given on the Pre-Test by both groups that were subsequently changed to a correct answer on the Post-Test. Given that the treatment group performed better on both the Pre and Post tests, it is not surprising to see that in this case the treatment group converted more incorrect Pre-Test answers into correct Post-Test answers. Row three shows that both groups converted a mean of three correct Pre-Test answers into incorrect Post-Test answers. Perhaps the most interesting of the statistics can be seen in the fourth row, showing the number of correct Pre-Test answers provided by both groups where the same correct answer was given on the Post-Test. The control showed a mean of 12 correct answers on the Pre-Test that were consequently answered correctly on the Post-Test, while the treatment group performed better with a mean of 14 correct answers provided across the Pre and Post tests.

The most obvious performance gap between the two groups was shown to exist in the mean number of incorrect answers given in the Pre-Test that were also translated to the Post-Test, with the control group returning 10 incorrect on both tests to the treatment group's figure of six. Overall, these figures indicate that participants in both groups converted more incorrect answers into correct answers than the converse, and that participants stayed with more correct answers across both tests than they did incorrect answers. The main conclusion that can be drawn from the data in Table 4-4 is that the treatment persisted with more correct answers and kept fewer incorrect answers between the Pre and Post tests, a contributing factor to that group's better Post-Test performance.

The Pre and Post test answer comparisons also showed that in both tests some participants did not attempt all questions. In the Pre-Test, a total of two control and one treatment group participants omitted questions, while in the Post-Test four participants from each group omitted questions in the Post-Test. None of the participants who omitted questions in the Pre-Test did so in the Post-Test. While this data may not be significant, it was thought unusual these participants would not at least guess at an answer rather than be assured of missing a possible score for a blank response. However, given the relatively large size of the Pre and Post tests, participants might have missed questions rather than deliberately leaving them blank.

4.3 Summary of Pre and Post Test Performances

The data presented in this chapter shows that the treatment group participants performed better in both the Pre and Post test instruments than the control group. Analysis indicates that both the control and treatment groups showed significant performance increase over time (between Pre and Post tests). The treatment group performed significantly better than the control group, a result attributed to that group's use of the CCS system.

The variables of gender and time for test completion were also analysed to gauge their impact on the performance of the two groups, with results indicating that these factors did not test scores for either of the groups. However, the amount of time participants spent working with the content delivery was significant, with longer working times associated with higher Post-Test performance.

4.4 Usage Data

Clickstream data used in this analysis is a record of the control and treatment groups' interaction with their respective content delivery systems. Due to the unstructured nature of the control group's learning system, only basic log-in, log-out and file access information could be tracked, this data primarily being used to establish a pattern of normal usage against which to compare the treatment group usage. The clickstream data from the treatment group was richer in detail and quantity and allowed for in-depth analysis due to the hyperlink-driven interface of the CCS system and the clickstream recording functions encoded into the system.

4.5 General System Usage

The control group was asked to use the weekly learning materials and follow the same working pattern as they would in any week of the semester. Participants in the control group were given a URL to the WWW server hosting a replica of eLCMS, this replica system being tied into the control group account system, each participant being required to complete the Pre-Test before being granted access to the eLCMS. Once the Pre-Test had been submitted the participants in the control group could access the weekly learning materials within the eLCMS as often as they wished, with each login and access to the files being recorded in the clickstream user logs. Once participants had completed all the work they intended to do for the week, they were asked to complete the Post-Test and the online learning survey. The treatment group participants were required to complete all their learning materials, in their case as controlled by the CCS system, only being able to access the Post-Test instrument and online learning survey once all three sections of the CCS materials had been completed.

The completion times indicates that twice as many control group participants completed in the two day or less category than members of the treatment group (Figure 4-4). This figure, when combined with the other two time categories indicates that nearly two thirds of the control group completed in two days or less, while two thirds of the treatment group completed in three days or more.

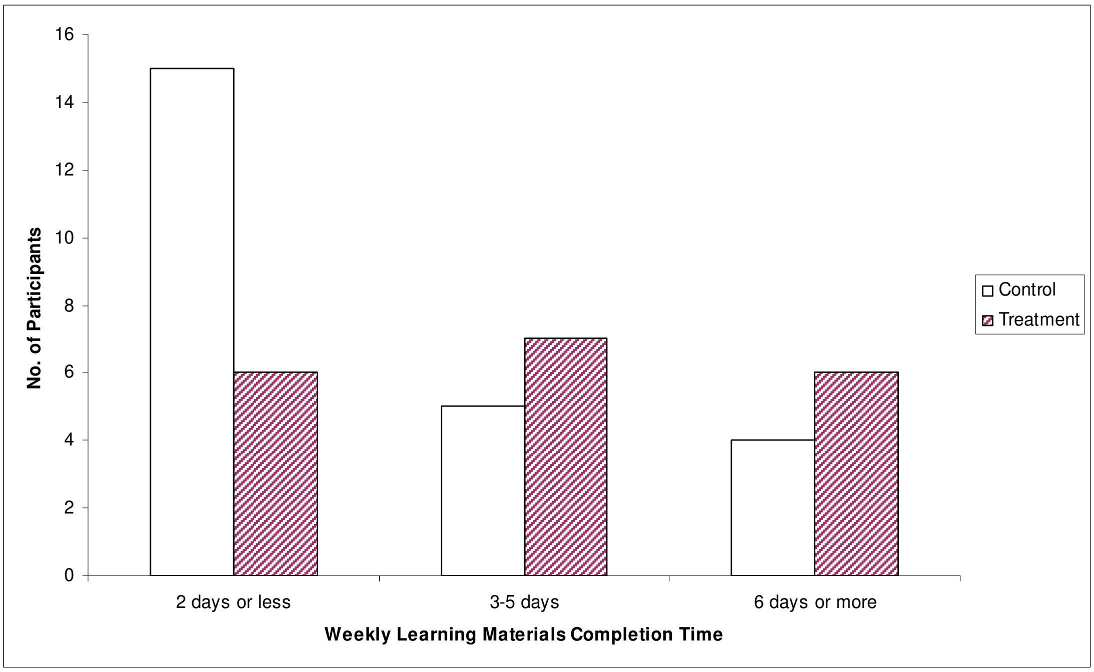


Figure 4-4: System completion times for both groups

Within the two day or less time category, six participants within the control group spent less than an hour 'working' with the eLCMS and materials before moving to the Post-Test. The minimum time spent on the sequenced version of the learning materials was just under six and a half hours, this being the only instance of a treatment group participant taking less than a day to complete the materials. While it was possible to move through all the learning materials in the CCS version of the course within approximately 20 minutes, assuming that no effort was given to the 12 learning assessments or learning materials, it was expected that most participants would get through the system in three to four continuous working hours.

Over the period of the study the number of logins to the eLCMS and CCS systems by the two groups varied, with the treatment group showing more logins than the control group for participants taking more than two days to complete the learning materials (Figure 4-5).

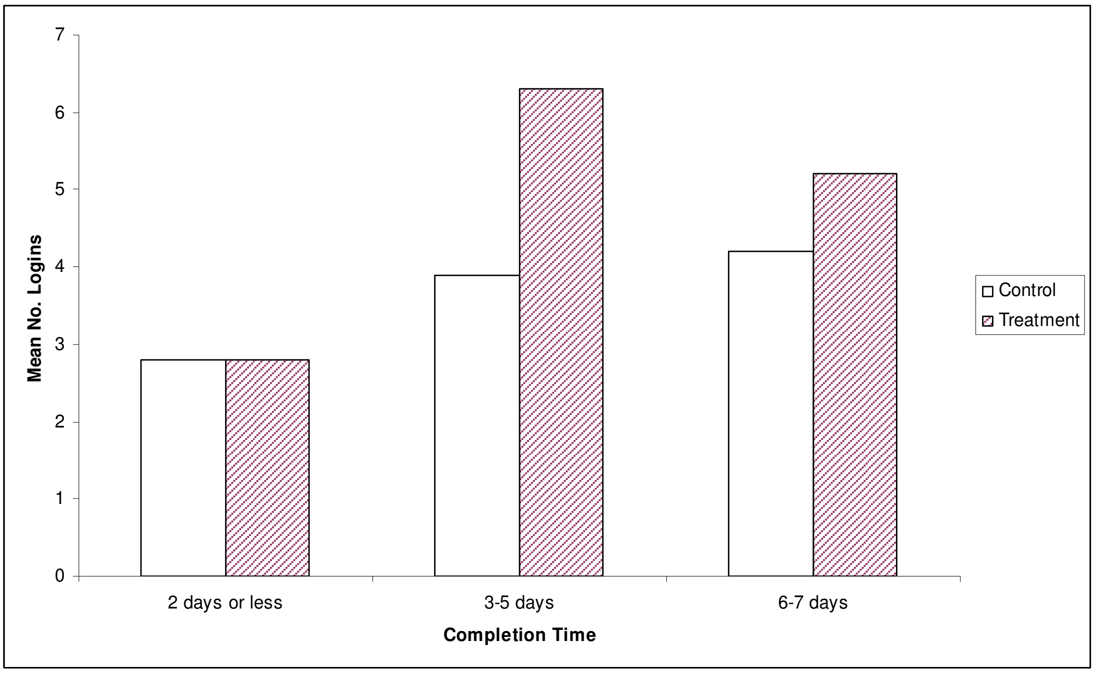


Figure 4-5: Mean logins for control and treatment groups by time category

Looking at the treatment group figures for logins to the CCS system over the period of the study, it was initially expected that these participants would have a tendency to log in more often than the control group. This reasoning developed from the fact that the control group participants could theoretically download all their learning materials at once, obviating the need for frequent visits to the eLCMS, whereas the treatment group participants would need to work with the CCS system in an ongoing basis, returning frequently to continue through the materials and assessments in each section. This expectation appeared to be mostly correct, with the treatment group showing more login activity than the control group, particularly where participants required three to five days to complete their respective learning materials.

If it can be assumed that the login pattern shown by the control group was 'typical' of student usage of the eLCMS (logins increasing with time), then it could be argued that participants in the treatment group applied their normal system access patterns to the usage of the CCS system. The importance of trying to establish a ‘typical’ pattern of student behaviour, in this case measured against the eLCMS system, was to eliminate influences other than the eLCMS and CCS systems as variables affecting student performance outcomes. Returning to Figure 4-5, there was greater variance between the two groups in terms of completion times than logins, with the low completion time figures for the control group being the main difference. Given that the control group participants had no constraints placed on them beyond their initial login to the eLCMS system before moving to the Post-Test, the low completion times for that group are not surprising. Given the trends for both groups shown in Figures 4-4 and 4-5, it is not unreasonable to assume the treatment group participants used the system in generally the same way as they would have the normal eLCMS system, with the higher completion time values being a product of CCS method of content delivery.

4.6 Controlled Content Sequencing Usage

To measure how participants in the treatment group interacted with each type of learning material in each section of the CCS system, the total time on each item was recorded, as was the Number of Clicks (NoC) and finally, the score for the assessment associated with each piece of learning material. The time on task was calculated as the interval between when a piece of learning material was clicked on until the submission of the associated assessment item. The format of the clickstream data recorded for each participant’s usage of the CCS system is shown in Table 4-5.

Table 4-5: Clickstream data format example

ObjectName	ActionPerformed	TimePerformed
Lecture Part 1	ClickLearningObject	12/08/2004 7:29:15 PM

When the CCS system was in a state where a learning item and associated assessment were both available, a participant could move freely between the two by clicking on their links, the assessment being available until it was submitted for marking. Clickstream data shows that participants regularly clicked backwards and forwards between learning items and the associated assessment items, most likely looking at the questions in the assessments before referring back to the learning item in order to locate the answers. In an attempt to categorize the different usage patterns established by the participants in the CCS system, this method of back and forth navigation was defined as the 'hunt and peck' method, whereby students seemed intent on finding keywords in assessment items that they could then use as a search term back in the actual learning materials. The questions in the assessments were carefully designed to avoid the use of obvious keywords, making it difficult to find answers in the learning materials, especially the readings, by using the 'hunt and peck' method. An example of clickstream data for a participant thought to be using this method is shown in Table 4-6.

Table 4-6: Example of 'hunt and peck' study method

ObjectName	ActionPerformed	TimePerformed
Workshop part 1	ClickedLearningObject	10/08/2004 10:48:18 PM
Workshop part 1 assessment	ClickedAssessmentObject	10/08/2004 10:48:26 PM
Workshop part 1	ClickedLearningObject	10/08/2004 10:48:38 PM
Workshop part 1 assessment	ClickedAssessmentObject	10/08/2004 10:49:16 PM

The participant has switched back and forth between part one of the workshop files and the associated workshop assessment twice over the period of one minute, after which the assessment item was submitted. This particular example had a duration of 58 seconds and a NoC value of four, where the duration is measured from the first time the learning item was clicked until the last time the assessment item was clicked.

Another example of the 'hunt and peck' method seen in the clickstream data is where the participant used their WWW browsers Back button to move from an assessment item back to a learning item, rather than using the provided links. In such a situation, the clickstream data looked like that shown in Table 4-7.

Table 4-7: Alternate representation of 'hunt and peck' study method

ObjectName	ActionPerformed	TimePerformed
Lecture part 3	ClickedLearningObject	17/08/2004 2:00:26 PM
Lecture part 3 assessment	ClickedAssessmentObject	17/08/2004 2:00:32 PM
Lecture part 3 assessment	ClickedAssessmentObject	17/08/2004 2:00:47 PM
Lecture part 3 assessment	ClickedAssessmentObject	17/08/2004 2:00:59 PM

The clickstream data indicates that the participant has clicked on the lecture item, then clicked the associated assessment, then used the Back button on their browser to return to the lecture item, then repeated this process twice more. The first, second and third clicks on the lecture assessment item were recorded because the coding and configuration of the CCS system would not allow participants to return to the assessment item using the Forward button on their browsers, as such an action presented the participant with a session related code error, so the participant had to click on the assessment link.

The ‘hunt and peck’ approach by participants using the CCS system was an unexpected outcome from the clickstream analysis. While thus far an assumption has been made that the ‘hunt and peck’ method was used by participants to search for answers within the written text, it could also be that some participants were using this method to focus their reading. However, in most instances of the ‘hunt and peck’ method appearing in the clickstream, the time duration values do not support this alternative explanation.

Some authors within the field of hypermedia systems (see section 2.1.5 of Chapter 2) believe that to constrain users within a system whereby they cannot progress until they reach a certain performance level generally leads to abandonment of the system by the users. To this end, participants in this study were allowed to move forward to the next section of the CCS system after their second attempt at a section, regardless of performance. Once participants became aware of this (usually after two attempts at section one), some demonstrated a more relaxed approach to sections two and three. Beginning with the basic usage data, Figure 4-6 shows the number of participants who required multiple attempts at the three CCS sections.

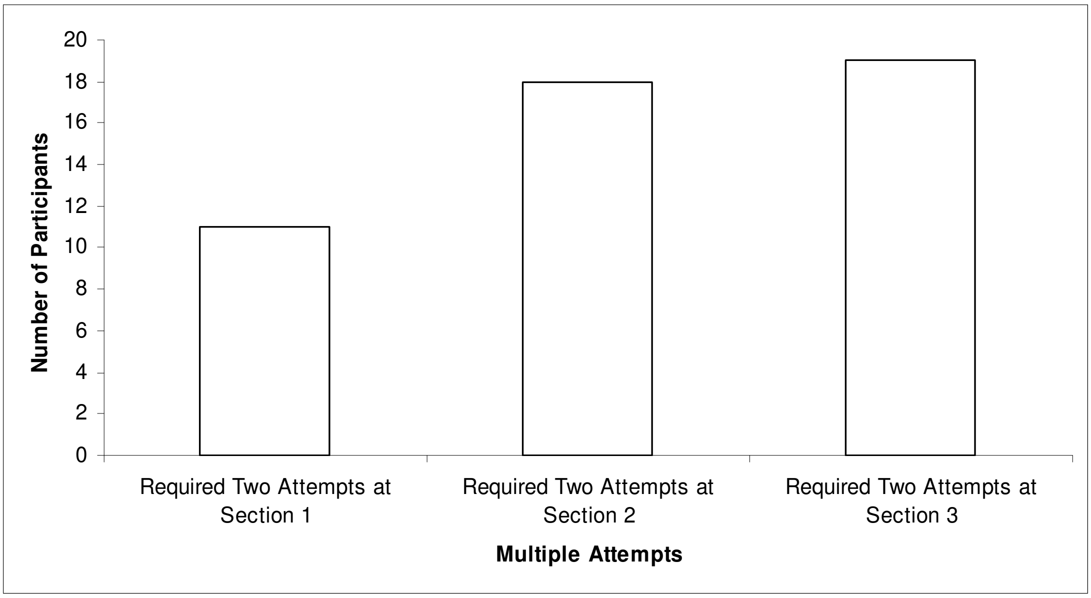


Figure 4-6: Participants requiring multiple attempts at individual sections (out of 19)

As Figure 4-6 indicates, 11 of the 19 participants' required two attempts at section one, 18 participants needing two attempts at section two, and all participants needing multiple attempts at section three. If a participant's combined lecture, reading, workshop and section review score was less than the pass score for the section, a second attempt at the section would be required. The three section pass scores were set at 14, 17 and 19 respectively, with sections one and two being out of a possible 22 (Lecture=5, Reading=5, Workshop=5, Section Review=7) while section three was out of 23 (Lecture=5, Reading=5, Workshop=6, Section Review=7).

The relaxed attitude, raised previously, becomes apparent when looking at the second attempt statistics for section two, where none of the participants repeating the section reached the passing score on the second attempt. Similarly, no participants reached a passing score on their second attempt at section three. In fact, the mean second attempt performance for each section was slightly lower than for the first attempt across all three sections (Table 4-8).

Table 4-8: First and second attempt (A1,A2) mean scores, clicks and time per learning item

	Scores		**Clicks**		**Time (hh:mm)**	
	A1	*A2*	*A1*	*A2*	*A1*	*A2*
Section 1						
Lecture 1	3.1	3.2	2.6	3	03:26	01:16
Reading 1	3.2	3.1	2.9	2.7	00:19	00:01
Workshop 1	2.6	2.4	2.9	2.8	03:00	00:03
Mean	*2.9*	*2.9*	*2.8*	*2.8*	*02:15*	*00:27*
Section 2						
Lecture 2	2.7	2.8	2.7	2.6	01:14	00:01
Reading 2	3.2	3.4	2.7	2.3	00:22	00:01
Workshop 2	2.8	2.2	2.6	2.2	02:53	00:01
Mean	*2.9*	*2.8*	*2.7*	*2.4*	*01:30*	*00:01*
Section 3						
Lecture 3	2.7	2.4	2.7	2.4	03:52	00:01
Reading 3	3.2	3.4	2.6	2.3	00:06	00:01
Workshop 3	2.9	2.5	2.2	2.2	03:24	00:01
Mean	*2.9*	*2.8*	*2.5*	*2.3*	*02:27*	*00:01*

The performance gap between each attempt was minimal, and that second attempt performance improvements were evident in two lecture and two reading assessments (Table 4-8). The mean NoC value for each learning item showed little variation between first and second attempts across the three sections. Participants seemed willing to work on the first attempt at each section for a moderate amount of time, but not on the second attempt. The mean completion time of 27 minutes for attempt two in section one is much higher than the subsequent second attempt times in sections two and three, a result that could be related to participants realisation (after section one) that there was a two attempt limit for each section. As a result, those requiring a second attempt at sections two and three (most participants) would seem to have simply raced through all the assessment items in the section so as to move onto the next section as quickly as possible. It would appear that the second attempt mechanism did not contribute to improving student performance within the CCS system, and that it was treated as more of a hindrance than as a tool for topic reinforcement.

Overall, the lecture materials received the most amount of working time from the participants, followed by the workshop items with the readings attracting the least amount of working time. This value for the readings was somewhat lower than anticipated as each of the three documents was quite substantial, particularly readings two and three, leading to the expectation that participants might spend more time working on these items. This expectation was purely subjective and did not account for participant reading speed, or that the 'hunt and peck' method may have been successfully used on the readings by some or all of the participants, though the mean NoC values for the readings does not indicate increased click traffic to the readings. To establish a baseline for the length of time required to complete each reading, a trial was conducted with nine individuals, three per reading item (Table 4-9). The results of this trial indicated that reading one could be completed in approximately six minutes, as compared to the mean of 19 minutes for the treatment group participants. For reading two the trial group showed a mean of 15 minutes as compared with 22, while reading three had the trial group taking 22 minutes where the treatment group took six.

While the trial reading exercise was hardly conclusive, it would appear to indicate that for the first two readings participants in the treatment group spent sufficient time on the materials to both read all the content and revise in order to sit the associated assessments. However, the results from both sets of data shows the reading time of six minutes for reading three to still be an anachronism when compared to the times reported by the trial group.

Table 4-9: Mean trial reading times

	Reading Time (SD)
Reading 1	6 (1)
Reading 2	15 (2)
Reading 3	22 (2)

Given these trial reading times versus the actual student reading times, the NoC values and the scoring performance for the reading materials, three likely explanations for the above results are;

Reason One: The reading materials were on the same topic as the lecture materials, with the readings being more detailed and following directly after the lecture items. It seems likely that given the substantial time spent on the lecture items by the participants, the reading materials would have been largely revisions of that content but in more depth. Students could have simply skimmed the readings, focussing on new concepts only. Given the score discrepancies between the lecture/reading materials and the workshops, which contained completely different content, this explanation seems highly likely.

Reason Two: The students in the treatment group might have covered the networking and protocol topics in other units previously and thus were more highly conversant with such content. However, an analysis within the treatment group answers provided in the Pre-Test to the 19 networking and protocol specific questions indicated a mean score of 11 (SD=3), which could be considered a passing level of knowledge at best.

Reason Three: That the assessments associated with the readings (and lectures) were easy to locate answers for using the 'hunt and peck' method within the associated learning item, and that attempts to dissociate keywords from content was not as successful as originally intended.

Even though the reading materials received the smallest amount of working time, reading three in particular, the performance figures for those items were consistently the highest across all three sections, followed by lecture then workshop materials.

It was initially thought that the amount of variation in assessment answers between first and second attempts may have influenced student performance; with the ranked percentage of questions answered the same on the first and second attempt at each learning assessment item shown in Figure 4-7. The workshop materials appears to be where participants varied their answers the most, with the lecture items in the middle of the range and the readings showing the least amount of variation. The variation in the workshop answers between attempts one and two could be due to the technical nature of each workshop item and the fact that several of the workshop assessments had questions related to code which the participant was supposed to have written.

If participants had not completed all the exercises within each workshop, then the assessment questions, particularly those requiring code snippets to be written into fill in the blank fields, would be difficult to answer correctly. If as a result of this, participants performed poorly, it could be that on the second attempt at each workshop they simply altered their responses, trying to guess the correct answers. Using this same logic when looking at the reading, the high answer retention rate might indicate that participants were confident in their answers, likely due to their proximity to the lecture materials (as indicated above).

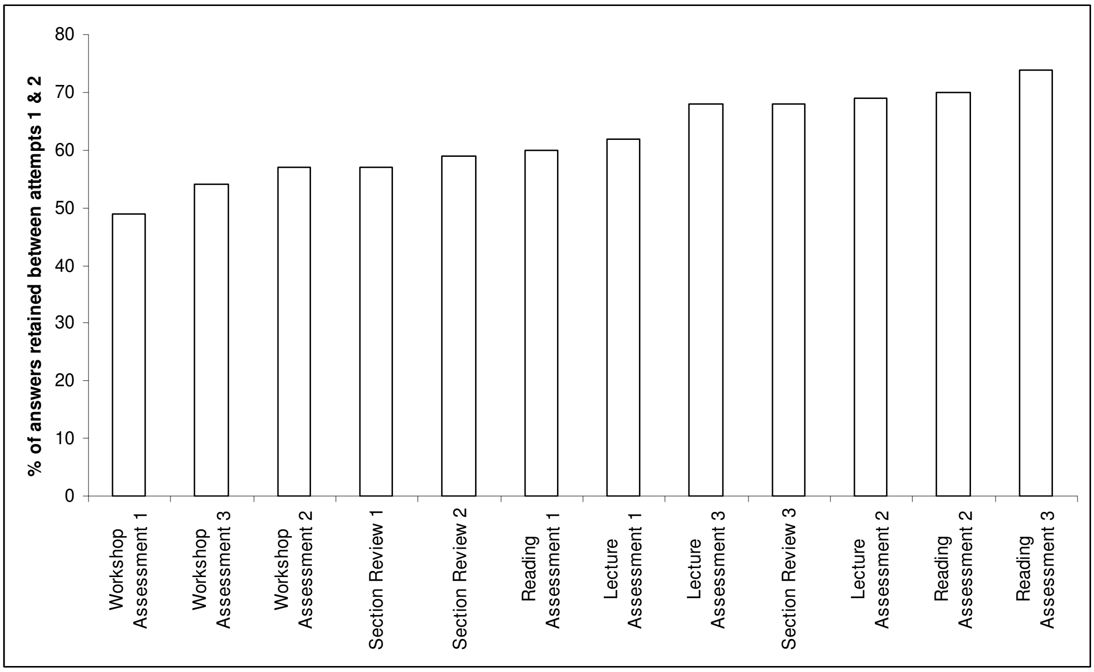


Figure 4-7: Percentage of questions answered the same on the first and second attempt at a learning assessment (ranked lowest to highest)

Two interesting usage patterns appeared during the analysis of the assessment answers, the first being that students were leaving questions blank, the second showing that students were attempting to submit assessments more than once but with different answers, even though the system did not allow for this. Fourteen participants left one or more questions blank across the learning assessment items, sometimes leaving a question blank on a first attempt, but completing it on the second attempt, or more often than not, leaving the same question blank on both attempts at the assessment item. Of the 26 questions left blank across the three sections of the CCS learning materials, 25 of those were fill in the blank style while the other was multiple choice. This could indicate that participants were not willing to spend the time required working through the lecture, reading or workshop materials in order to find the correct answers. Participant understanding of how the system interpreted and matched string data in these questions might also have contributed to the poor response, as previously discussed in section 3.8.5 of Chapter 3.

The number of participants who tried to submit assessments multiple times, each time with a different set of answers, was another unexpected outcome from the data analysis. The CCS system was designed so that assessments could only be submitted once, after which a server-side session was created to prevent subsequent submissions. Participants could use their browser Back buttons to go back to the assessment, provide different answers and click submit again, at which point the system would generate a message indicating that the assessment had already been marked. Thirteen participants tried at least once to immediately re-submit their assessment with different answers, most possibly after receiving a score not to their liking. Of these 13 participants, seven attempted it more than once, while the remaining six did not try it again after the initial instance. It is assumed that these six participants realised they could only submit their assessments once (the CCS system presented ongoing progress scores), while perhaps the other seven did not believe the error message they received and believed that their second, third and in some cases fourth attempt would all register a different score.

4.7 Summary of System Usage

Although the control group showed quicker completion times for the weekly learning materials due to a number of very quick completions, the usage patterns for the two groups from a system access perspective were largely analogous. For the control group the workshop materials were the most heavily accessed, followed by the lecture and reading materials. Clickstream data from the treatment group indicated that the reading materials were the most frequently accessed, followed closely by the workshop materials and then the lectures.

Participants seemed unimpressed with the multiple attempts model incorporated into the CCS system, with second attempt scores being lower in more than half the assessments items, and section completion times falling from hours to minutes. Though the reading assessments received the lowest first and second attempt completion times, these were the items where participants showed the best scores, and also scoring improvement between attempts.

When examining the very low average time spent on the learning materials and associated assessments on a second attempt at a section, combined with the number of participants who did not attempt the fill in the blank style questions, it could be postulated that speed of progress rather than depth of learning was the goal of the participants. This attitude seemed especially apparent in those participants who consistently tried re-submitting assessments with different answers, perhaps in the hopes of better performance without the need of repeating a section of content.

Overall the performance section of the research was extremely useful in gauging the effect of the CCS system on student learning performance as compared with the eLCMS, at least from an empirical standpoint. The data collected from the Pre and Post test instruments was crucial in illustrating the significant difference in learning performance between the two groups, showing that the CCS approach is beneficial. The data for gender, time and age, while interesting in some places, did not show that these factors were significant for the performance differences between and within the two groups.

Chapter 5

5.0 Attitude data

This chapter examines the attitudes of the control group, the treatment group and members of academic staff. While the student participants from the control and treatment groups were asked to fill in an online survey after completing the Post-Test, academic staff were given an in-depth description of the CCS system and asked to evaluate the concept in an online survey.

The attitudes responses gained from the survey instruments was designed to clarify the usage patterns identified from the clickstream data, and to address student and staff reaction to the design concepts and features of the eLCMS and the CCS systems. This chapter addresses the second and third supporting research questions;

Supporting question two

"**What effect does Controlled Content Sequencing have on student usage of online learning materials?**

Supporting question three

"What design attributes and implementation factors affect student and staff reaction to Controlled Content Sequencing?

5.1 Control and Treatment Group Common Items

This section examines the responses to the common survey questions presented to both the control and treatment groups. The primary focus of the common survey questions was to establish how participants in the treatment group normally used the eLCMS, and whether that pattern of usage affected their responses to the CCS system. The same questions were given to the control group for the purposes of comparing their responses to that of the treatment group to see if both groups use the eLCMS the same way, which to a certain degree would indicate if the treatment group used the learning materials in a 'typical' fashion.

5.1.1 Section One: Technology experience and access

Item 1.1 showed that participants from both groups agreed that they were comfortable using computing technology, a result that is perhaps not unusual given that these were students studying in a school of computing and information science (Table 5-1).

Table 5-1: Item 1.1, I am comfortable using computing technology (%)

	SA	**A**	**N**	**D**	**SD**	**NA**
Control (N=24)	63	32	5	0	0	0
Treatment (N=19)	58	38	4	0	0	0

Item 1.2 saw nearly all participants considering themselves as competent users of computing technology, with the exception of a single control group member who disagreed with the statement (Table 5-2). The student in question had English as a Second Language (ESL), and often sought clarification of learning materials and instructions, though his actual hands on computing capability seemed to be well developed.

Table 5-2: Item 1.2, I classify myself as a competent user of computing technology (%)

	SA	**A**	**N**	**D**	**SD**	**NA**
Control (N=24)	58	38	0	4	0	0
Treatment (N=19)	58	37	5	0	0	0

Item 1.3 indicated that approximately 50% of participants from both groups worked on their learning materials at home, while more of the treatment group worked on their materials at university than did the control group (Table 5-3). One quarter of the control group indicated that they worked on the materials equally at home, work and university, as compared to only 16% of the treatment group working in the same way.

Table 5-3: Item 1.3, I mainly access the e-learning resources from (%)

	Home	**Work**	**University**	**All Equally**
Control (N=24)	54	0	21	25
Treatment (N=19)	47	0	37	16

The number of participants working on-campus (21% and 37% respectively for the control and treatment groups) could be related to students living very close to the campus, or in on-campus student housing in the case of international students. Some students may not have had access to the required software on their home computers (such as in the case of the various programming, scripting and database systems used within the unit in question). In the past two to three years students had often become impatient with trying to configure their home computers to work like those in the teaching labs, especially when trying to match operating systems, WWW server, database server and scripting language versions and configurations exactly. Students often found it easier to work on-campus where the machines were configured consistently, rather than bring in code from their home configurations that worked at home, but not on-campus. The movement between home, university and work might also explain the system access patterns shown for both groups, in that participants would log into the systems and download the materials to their current working environment rather than carrying the files with them.

5.1.2 Section Two: E-learning experience

The second section of the student survey was designed to gain an understanding of any content delivery systems participants in the study might have had previous experience with. Item 2.1 showed more than 80% of participants from both groups agreeing that they were experienced at using online learning systems, with more than a third of the control group strongly agreeing (Table 5-4).

Table 5-4: Item 2.1, I am experienced at using online learning systems (%)

	SA	A	N	D	SD	NA
Control (N=24)	38	50	12	0	0	0
Treatment (N=19)	16	68	16	0	0	0

Item 2.2 has both groups of participants seeing themselves as competent users of the eLCMS, with 92% agreement from the treatment group and 84% from the control group (Table 5-5). Interestingly, the student in the control group who disagreed was again User17. It would appear that this student did not have a great deal of self confidence in relation to his technical skills, or the systems he regularly used as a part of his studies.

Table 5-5: Item 2.2, I am a competent user of the eLCMS (%)

	SA	A	N	D	SD	NA
Control (N=24)	42	50	4	4	0	0
Treatment (N=19)	47	37	16	0	0	0

While the first two items in section two had participants gauge their familiarity with online learning systems as well as their competence in using the eLCMS, the third item asked participants what online learning environments they had previously used (Table 5-6).

Item 2.3 shows more than half of the control group participants as having used WebCT or Blackboard (both of which were used at the university), while 75% of the responding treatment group participants had used other systems.

Table 5-6: Item 2.3, Aside from the eLCMS, which of the following online learning systems have you used (%)

	WebCT	**Blackboard**	**Other**
Control (N=22)	23	23	54
Treatment (N=16)	19	6	75

Thompson's NetG online training system was the 'other' option selected by seven and five members of the control and treatment group respectively, while one participant from each group selected Cisco's NetAcad. The NetG materials were available within the school in question, while the NetAcad materials were available for participants in networking specific units. These results would indicate that the 'other' online learning systems used by the participants were those that were available within the school or throughout the university. Two interesting selections were the W3Schools site and the Google search engine. Perhaps by a student definition, any sight that assists them in any type of learning, or even in finding such a site, is worthy of the classification as an online learning system.

5.1.3 Section Three: eLCMS usage

Item 3.1 had 63% of respondents in the control group agreeing that they printed and read the materials from the eLCMS, while a total of 69% of the treatment group agreed (Table 5-7). The control group had 17% of participants undecided as opposed to the treatment group's 11%. More participants from the treatment group disagreed that they printed and read the materials, while two members of the control group thought the statement was not applicable.

Table 5-7: Item 3.1, I print then read the resources provided on eLCMS (%)

	SA	A	N	D	SD	NA
Control (N=24)	21	42	17	8	4	8
Treatment (N=19)	37	32	11	20	0	0

Item 3.2 showed that the control had a greater preference for reading materials directly from the screen, with 80% agreeing compared to the treatments group's 64% (Table 5-8). Comparing the results between items 3.1 and 3.2, it would appear that the control group preferred to work with the learning materials on-screen, while the treatment group was more in favour of printing the materials first before reading them.

Table 5-8: Item 3.2, I read the resources provided in eLCMS straight from the screen (%)

	SA	A	N	D	SD	NA
Control (N=24)	17	63	8	8	4	0
Treatment (N=19)	11	53	16	4	16	0

Item 3.3 was designed to establish the level of reliance that participants had on the eLCMS (Table 5-9). This question was central to addressing one of the issues that influenced the origins of this research, whereby students would stay enrolled in a unit of

study for a whole semester, yet use the eLCMS and the materials it contained sparingly. The control group was quite emphatic in their response to item 3.3, with 79% disagreeing that they used the eLCMS rarely, while two participants agreed with the statement.

Table 5-9: Item 3.3, I find I can get through my units only using the eLCMS rarely (%)

	SA	A	N	D	SD	NA
Control (N=24)	0	8	0	50	29	13
Treatment (N=18)	6	17	33	11	22	11

Nearly a quarter of the treatment group agreed that they were comfortable using the eLCMS only rarely, while a third disagreed. Nearly a third of the treatment group neither agreed nor disagreed, perhaps indicating moderate or infrequent users of the eLCMS.

Item 3.4 builds on item 3.3, asking participants if the reason for not referring back to the system regularly is due to downloading a semesters worth of content at the beginning of the semester (Table 5-10).

Table 5-10: Item 3.4, Where an entire semester's worth of content is available at the beginning of semester, I download all materials and rarely refer back to the eLCMS (%)

	SA	A	N	D	SD	NA
Control (N=24)	0	21	4	25	42	8
Treatment (N=19)	16	5	5	47	21	5

Item 3.4 showed almost identical attitudes for both groups, with 21% of control and treatment group participants indicating agreement, while 67% and 68% respectively indicated disagreement. Looking at this result and that for the previous item, it would appear that a minority of participants from both groups agree that they only use the eLCMS rarely, especially if the materials are available up-front at the beginning of semester. This minority included one treatment group and two control group participants, each of which agreed or strongly agreed with items 3.3 and 3.4.

5.1.4 Section Four: Study practice

The questions contained in section four of the online student survey examine the study practices of participants once they have obtained their weekly learning materials. In response to item 4.1, 92% of participants in the control group agreed that they normally worked with learning materials in the week they were presented, while 79% of treatment group participants similarly agreed (Table 5-11).

Table 5-11: Item 4.1, My usual study practice is to work with the materials in the week presented (%)

	SA	**A**	**N**	**D**	**SD**	**NA**
Control (N=24)	25	67	4	4	0	0
Treatment (N=19)	5	74	11	5	5	0

The item 4.1 results would indicate that participants from both groups either worked on the materials in the week they were presented, or worked on them earlier. In hindsight, it might have been more useful to ask participants which materials they worked on and in what order, such as before the week they were presented, on the week they were presented, or after the week they were presented.

Item 4.2 differed slightly from item 4.1 in that it asked participants if they completed all materials, rather than simply worked on the materials and activities in the week presented (Table 5-12). This difference was to gain an understanding of how participants approached their weekly learning materials. This research originally developed from a concern with students accessing, but not utilising, the weekly learning materials presented throughout a semester of study. Item 4.1 and 4.2 were intended to obtain data indicating whether this was indeed the approach used by students.

Item 4.2 results show only 63% and 58% agreement for the control and treatment groups respectively to the concept of completing all learning materials in the week presented, with fully one quarter of participants from both groups neither agreeing nor disagreeing. This result, compared to the much more positive response for the previous item, would indicate that participants from both groups did indeed access their learning materials on or before the due week, but that they were less likely to complete all the materials at the given time.

Table 5-12: Item 4.2, I complete all the weekly materials and activities in the week presented (%)

	SA	A	N	D	SD	NA
Control (N=24)	17	46	25	8	4	0
Treatment (N=19)	5	53	26	16	0	0

Items 4.3 and 4.4 were designed primarily to gauge how the participants from both groups perceived their own learning capabilities. Item 4.3 showed that almost 90% of the control group participants' agreed that they knew how they learned best, while three quarters of the treatment group indicated agreement (Table 5-13). One of the three control group participants who neither agreed nor disagreed with the statement in item 4.3 was again User17, a participant who had consistently provide responses that indicated a lack of self confidence.

Table 5-13: Item 4.3, I know how I learn best (%)

	SA	**A**	**N**	**D**	**SD**	**NA**
Control (N=24)	21	67	12	0	0	0
Treatment (N=19)	21	53	21	5	0	0

The participant in the control group with the best performance outcome between the Pre and Post test was also one of the participants who selected the N response for item 4.3. It appears that, when examining score differences between the Pre and Post tests, that those participants in the control group who indicated they had a strong understanding of their own learning in fact performed quite poorly, while the participant from the same group who was unsure about her own learning style actually showed the best performance.

The four treatment group participants who strongly agreed that they knew how they learned best were indeed among the top performers in that group (between Pre and Post tests), with the two best performers also indicating agreement (Table 5-13). These responses, along with the performance differences between the two groups, would indicate that while the control group seemed more certain of their own best learning practice, their performance results did not reflect this belief.

Item 4.4 showed 96% of the control group agreeing that they preferred to study at their own pace, while 90% of the treatment group also agreed (Table 5-14). Whether this high level of agreement to item 4.4 would preclude participants accepting a content delivery approach like the CCS system is, on its own, hard to gauge. However, as the responses in sections seven and eight demonstrate (for the treatment group), it would appear to be a factor.

Table 5-14: Item 4.4, I prefer to study at my own pace (%)

	SA	A	N	D	SD	NA
Control (N=24)	38	58	4	0	0	0
Treatment (N=19)	27	63	5	5	0	0

5.1.5 Section Five: Most favoured features of eLCMS

Section five of the student survey presented both student groups with an opportunity to write unstructured comments, in three blank text fields, listing the things they liked most about the eLCMS. The following are some selected comments from the open-ended responses provided by participants from the control and treatment groups when filling in the survey instrument. These comments are those selected as being 'most favourable'.

5.1.5.1 Control Group Comments

"Access to materials at any time." – User01

"Can access from any where" – User11

"Availability" – User12

"Be able to get all the resources required for the unit" – User16

"Accessible from home" – User25

"Efficient (quick to download different materials on each courses you enrolled)" – User17

"Always being able to access information" – User02

"Easy and quick access to materials regardless of one's proximity" – User24

"ease of access to unit materials" – User07

"easy, dont have to carry books or notes" – User11

"Information is provided for you if you have to miss a lecture" – User12

"Every week has been set in the schedule, so that you can refer to any week's content at any time." – User08

5.1.5.2 Treatment Group Comments

"Access to course materials" – User38

"Easy to access" – User41

"A major part of the course is available on-line so i am able to work full time and do a full time course." – User45

"Course materials are available at all times." – User59

"most of the martials are in for the whole semester" – User67

"materials are always uploaded before the lecture enabling student to read/do activities in advance" – User46

"Allows me to study at my own pace. Very important not to revert to Teachers Training College mentality." – User60

5.1.5.3 Summary of section five responses

The control and treatment group responses to the unstructured items in section show the importance of system and content access to participants, as well as the availability of all semester materials. Two interesting comments included the control group participant who referred to the ability to miss a lecture but still have the learning materials, while a treatment group participant mentioned studying at his own pace and did not want to be subjected to a "Teachers Training College mentality". Given that the student had just finished interacting with the CCS system, it seems likely that this statement was aimed more at that system than at the benefits of the eLCMS.

5.1.6 Section Six: Least favoured features of eLCMS

Section six of the student survey presented both student groups with an opportunity to write unstructured comments, in three blank text fields, listing those features they liked least about the eLCMS.

5.1.6.1 Control Group Comments

"hard to read from screen, have to print out" – User11

"Not normally enough notification when/if materials alter slightly throughout the semester." – User21

5.1.6.2 Treatment Group Comments

"It does not provide online quizzes to test yourself." – User45

"schedule page is Cluttered, unorganized" – User64

"never test student on what they learn in a way that build confidence and make student ready for exams and assignments." – User67

"You can't just download one big zip file of the semester's work." – User74

"Too easy to ignore/miss important materials." – User59

5.1.6.3 Summary of section six responses

Looking at the unstructured responses to section six for the two groups, it would appear that the treatment group responses were affected by their experiences with the CCS system. Comments from the treatment group regarding quizzes, tests and recording items that have been completed would indicate that, having used the CCS system, these are the items that that some of the participants saw lacking in the eLCMS.

The second statement from the control group participant pertaining to a lack of notification when staff change semester materials was interesting as this concern has been alluded to earlier in this study. To reiterate, this situation comes about when students download (and sometimes print) all learning materials at the beginning of semester, only to find that the materials can change as the semester progresses.

5.2 Treatment Group Items

Section seven examined the treatment group reactions to the CCS system and materials, while section eight focused on comparisons between the CCS system and the eLCMS. Section nine was similar to section five in that participants were given the opportunity to list those features they like most about the CCS system, while section 10 asked participants to list the features they like least.

5.2.1 Section Seven: Controlled Content Sequencing

Item 7.1 indicates that 13 of the treatment group participants liked the way in which the CCS materials were structured and sequenced, while five did not (Table 5-15).

Table 5-15: Item 7.1, I like the way in which CCS materials were structured and sequenced

SA	A	N	D	SD	NA
2	11	1	3	2	0

Given that that both the structure and sequencing elements of the CCS were addressed in item 7.1, item 7.2 looked focussed on the structure alone (Table 5-16). Little more than half of the treatment group participants agreed that the structured approach of the CCS assisted them in comprehending their weekly learning materials

Table 5-16: Item 7.2, I found the structure provided by the CCS to be helpful in my understanding and comprehension of the weekly materials

SA	**A**	**N**	**D**	**SD**	**NA**
1	9	4	4	1	0

The one participant who strongly agreed only returned a score improvement of +1, which would seem to indicate that though the participant thought the structure within the CCS system was beneficial to his learning, from a performance point of view, it was not. Of the five participants who disagreed with item 7.2, two also disagreed with item 7.1, indicating that at least some of the participants were not receptive to either the structure of the sequencing elements of the CCS system.

Item 7.3 was designed to ascertain participant reaction to the CCS system and its integration into their usual class based learning (Table 5-17). Responses indicated that less than half the participants in the treatment group agreed that the CCS worked well in conjunction with their class based learning. With one quarter of the participants opting to neither agree nor disagree, it could have been that some elements of the CCS were perceived as working well with class based teaching, while other elements were not. As a participant comment in a later section will illustrate, one of the concerns put forward by the students was that they had to complete most of the CCS materials before attending the lecture if they wished to bring printed copies of the materials to class.

Table 5-17: Item 7.3, I feel that CCS worked well in conjunction with class-based learning activities

SA	A	N	D	SD	NA
1	7	5	3	2	1

Item 7.4 compliments question 7.3, asking participants about how they perceived the CCS system as a content delivery method for online rather than on-campus teaching (Table 5-18). The school in which this study was conducted had several degrees running in a fully online mode, with remaining degrees being redeveloped in order to be made available online. The treatment group participants were aware of what was meant by the term 'fully online' in regards to mode of study.

Item 7.4 showed 13 participants in agreement, with only one disagreeing and five choosing to neither agree not disagree. Comparisons between items 7.3 and 7.4 indicated that participants in the treatment group would rather use the CCS system within a fully online unit of study, rather than use it in conjunction with their on-campus, class based learning.

Table 5-18: Item 7.4, The CCS would be better suited to a fully online mode of study

SA	A	N	D	SD	NA
3	10	5	1	0	0

Item 7.5 showed the most even distribution of responses to any within section seven, with seven participants agreeing that they were not bothered by the requirement to work through materials rather than download them, while a similar number disagreed.

The remaining four participants were undecided as to whether this key feature of the CCS system was inconvenient to them. A comparison of the mean completion time in days for those participants who agreed with item 7.5 showed a value of 3.8 days, against 4.4 days for those who disagreed. It was initially thought that those who disagreed might have moved through their CCS materials more quickly, but this was not the case. It could also be that these participants disagreed because of the very fact that the CCS system took longer to complete than to download the materials from the eLCMS.

Table 5-19: Item 7.5, The requirement to work through materials rather than download the whole weeks content at once does not bother me

SA	**A**	**N**	**D**	**SD**	**NA**
3	4	4	4	3	0

Item 7.6 showed that 11 of the treatment group participants felt more confident working on the weekly learning materials in a proscribed order, while five disagreed and three neither agreed nor disagreed (Table 5-20). The three participants who strongly agreed continued a pattern of positive responses to the CCS approach, while at the other end of the scale, the participant who strongly disagreed had done so for all statements regarding the CCS system.

Table 5-20: Item 7.6, I felt more confident working on the weekly materials knowing I was doing the work in the correct order

SA	**A**	**N**	**D**	**SD**	**NA**
3	8	3	4	1	0

Interestingly, given that 74% of participants in the treatment group agreed with item 4.3, “I know how I study best”, it was somewhat surprising that even half of the same group drew confidence from having the content provided to them in an optimised (from an instructor’s point of view) sequence.

Item 7.7 saw 12 participants agree that they found the CCS assessments useful for gauging their own learning performance, while five did not (Table 5-21). Student comments in a later section will show that while assessments items were popular, some of the questions (such as fill in the blank) and the inability to re-submit failed assessments did detract from the perceived usefulness of these items for some participants.

Table 5-21: Item 7.7, I found the constant assessment (tests) / feedback feature to be useful in gauging my learning performance

SA	**A**	**N**	**D**	**SD**	**NA**
3	9	2	3	2	0

Item 7.8 showed that fewer than half the participants thought that the lecture slides were the best suited for use with the CCS system, followed by the readings, then workshop materials (Table 5-22). Though two participants selected the *Other* option, no written content was provided by the participants. It is perhaps not surprising that the participants listed the workshop materials last, as these learning materials are usually the most sought after in any given week of study. This is most likely due to the workshop activities forming the basis of assessable work that counts towards the end of semester grades for a unit.

Table 5-22: Item 7.8, Which of the following content types do you think are best suited to CCS

Lecture Slides / Notes	Readings	Workshop activities	Other
8	5	3	2

5.2.2 Section Eight: eLCMS and CCS comparisons

While section seven of the student survey examined participant attitudes towards the CCS system, section eight asked participants to directly compare the eLCMS with the CCS system

Item 8.1 show 12 of the participants preferred the eLCMS, with four of participants undecided and three indicating disagreement (Table 5-23). Of the three participants who strongly agreed, two were the most consistent critics of the CCS system throughout section seven. The participant who had been the most positive towards the CCS system in section seven, agreed with the statement in item 8.1, indicating that although he seemed to enjoy using the CCS system, he too would rather work with the eLCMS. The three participants who disagreed with item 8.1 were those who had given the most positive responses to the questions in section seven.

Table 5-23: Item 8.1, I prefer the usual eLCMS method of content structure and delivery

SA	A	N	D	SD	NA
4	8	4	3	0	0

Item 8.2 indicates that 15 participants felt that a combination of the eLCMS and CCS systems would be beneficial, though whether this mixture includes the retention of the control aspects is not known (Table 5-24).

Table 5-24: Item 8.2, I feel a mixture of eLCMS and CCS content delivery methods would be beneficial

SA	A	N	D	SD	NA
5	10	2	2	0	0

In hindsight, it may have been prudent to follow this question with a list of the CCS features that participants might have wanted to see integrated with the eLCMS, such as assessments / quizzes, sectionalised content or progress tracking.

Item 8.3 combined concepts from sections three and four into a single statement, essentially asking participants if they preferred the eLCMS over the CCS. Item 8.3 indicates this was the case, with 16 participants agreeing that they preferred to download and use learning materials at their own pace and in their own sequence.

Table 5-25: Item 8.3, I prefer to download all the materials and work on them at my own pace and in the sequence I feel comfortable with

SA	A	N	D	SD	NA
6	10	1	1	0	1

It is interesting that though items 8.1 and 8.3 are essentially making the same statement, only 12 participants agreed with the former as compared with 16 to the latter. Perhaps participant perception of these questions does differ significantly with the change in wording, and the supposition of the word ‘structure’ in item 8.1 with the word ‘sequence’ in question 8.3.

Item 8.4 showed nine participants agreeing to the statement that they would like to see a system like the CCS used in their other units (Table 5-26). Nine participants were undecided while two strongly disagreed. The two participants who strongly disagreed were the same who had responded so through the CCS specific survey items.

Table 5-26: Item 8.4, I would like to see a system like CCS used in my other units

SA	**A**	**N**	**D**	**SD**	**NA**
3	5	9	0	2	0

Overall, the responses shown in section eight would seem to confirm that the attitudes displayed in section seven, that less than half of the treatment group participants would actually prefer working with a system that involved the CCS concepts. However, the responses to question 8.4 indicated that only two participants actually disagreed with the prospect of using the CCS system in their other units of study, with nearly half of the treatment group neither agreeing nor disagreeing with such a proposal. Of those that responded favourably towards the CCS system, most would appear to like specific features of the system, including assessments, structure and progress tracking.

5.2.3 Section Nine: Most favoured features of CCS system

Section nine of the student survey presented treatment group participants with an opportunity to write unstructured comments, in three blank text fields, listing those features they liked most about the CCS system.

Structure Related

“Well structured” – User46

“Materials are organised in a logical manner.” – User59

“Provides information in a useful structure.” – User45

“The breakdown of the martials into section made it easy to read and follow” – User67

“well structured to encourage correct learning sequence” – User57

Assessment Related

“Assessments” – User60, User41

“It had tests” – User74

“Easier to gauge your own understanding of the materials.” – User59

“multiple choice q are good to remember topics” – User39

“Testing after processing course materials. – User45

Feedback and Control Related

"It makes you learn your stuff" – User74

"made me to read the material at least once before printing" – User66

"feedback given as to progress/understanding" – User43

"It's necessary to understand one section before moving to the next." – User59

"Enforces Learning" – User41

The three categories of responses show that structure, assessment and feedback/control were the features of the CCS which participants appreciated the most. That the breakdown of materials into specific topics received comment indicates that at least one participant appreciated this approach. The responses to the assessments indicated the value students placed on these items for the purposes of self testing and gauging their own performance. The last two statements in the assessments' category relating to reading content first and receiving the question later and testing after course materials would seem to indicate that at least some of the participants appreciated the concept of the ongoing present and test approach of the CCS system, as opposed to a single test coming after all reading materials have been presented. The final category of feedback and control would seem to indicate that students did appreciate the feedback messages after each assessment, and the list of completed items including scores that the CCS presented when moving between sections or during login. The control aspect was included in this category of responses due to comments like indicating that the CCS system enforced learning and required participants to understand content before moving to the next section. As comments in the following section will indicate, while some participants did appreciate the control mechanisms that were fundamental to the CCS system, others saw these same mechanisms in a less positive light.

5.2.4 Section Ten: Least favoured features of CCS system

Section ten of the student survey presented treatment group participants with an opportunity to write unstructured comments, in three blank text fields, listing those features they liked least about the CCS system.

Control Related

“cant choose what order to do things in” – User39

“The secondary school teacher type control of the learning process.” – User60

“The fact that an assessment was included that controlled the progression, created an impulse for me to get through it as quickly as possible. It also did not allow voluntary redo of assessments. Nor did it allow answer checking of assessments as Cisco provides with its online material assessments.” – User60

Assessment Answers Related

“Doesn't mention what questions were wrong/right” – User41

“Unable to redo assessments before completing whole section.” – User59

“as study not exam I think it should allow student to be able to check their answer as soon as they submit their answer” – User67

“answers that have to be typed in too hard to get right as different meanings for answer” – User39

“Question can be ambiguous, answer seems to have to be exact to be accepted.” – User41

"When entering answer in review, a textfield did not allow me to enter correct answer - ie. did not allow correct number of letters (question what OSI acronym stood for - I tried to enter Open System Interconnection but it wouldn't let me put in the last letter" – User57

Second Attempt Related

"Having to repeat a section all over again if failed/Takes a long time to complete" – User41

"if fail, then I have to do it again. which is a bit annoying" – User69

"i learn best from feedback - wanted the quiz answers after the 2nd attempt - so could learn what i did wrong" – User54

"Assessments were extremely frustrating because all it told me was that I got questions wrong and should redo it. It didn't tell me which questions I got wrong. So I ended up guessing (and doing worse on my second time around because I changed the wrong answers)." – User38

Workload Related

"The section of the lecture have divided up to three part. it make the read feel that it is too much to read." – User48

"the set task was quite large" – User67

"took a long time to finish! being part-time made it harder especially when working full-time - too long in between attempts to learn effectively without revisiting, and seemed to be more work than usual?" – User57

The above responses indicate that control was indeed a concern for some participants and was thus raised as the feature they liked least about the CCS approach. The final statement within the category of control responses leads directly into the responses concerning assessments, with nearly all participants indicating that they want answers to assessments. It would also seem that participants would like the ability to re-do assessments immediately, rather than as a result of having to attempt an entire section of content again. One participant indicated that one the second attempt at assessments when repeating a section he mainly guess the answers, while others indicated that they expected the answers on the second attempt. Some students were also concern that the fill in the blank questions in the assessments were too difficult to get correct, with one participant indicating that there was not sufficient space to type the correct answer, even though his answer was not correct. The final category of responses indicated that some participants felt the workload for the CCS version of materials was too high, though aside from the assessments, the actual amount of content was exactly the same as the control group received.

Given that the CCS system used in this research was designed to collect data against the concept of controlled content sequencing, some of the 'unfriendly' features of the system, such as the control of access to the learning content and a policy of not providing answers to questions could have generated some negative reactions within the treatment group. Because student reaction to these various elements were crucial to the study, students were not informed about the decisions behind the functioning of the CCS. If the system were to be used in a more mainstream environment, and students were informed of how and why the CCS operated, reaction to some elements of the system could perhaps be different.

5.3 Staff Survey

The staff survey was modelled on the survey given to the treatment group participants, in that the first section of the survey asked questions in relation to the attitudes towards and usage of the eLCMS. The second section asked staff members to answer questions related to how they might possibly use the CCS system should they be given the opportunity. As explained previously, the staff members were given comprehensive background materials as to the purpose and functionality of the CCS system, and were also given the opportunity to use the system from a student point of view should they wish to see the system in operation.

5.3.1 Section One: eLCMS teaching practice

Item 1.1 indicated that three quarters of the staff respondents agreed that they had significant expertise in the area of online or e-learning (Table 5-27). This result was not surprising as the eLCMS had been in use for several years and had been the required medium through which learning materials were delivered to students by staff. The participants who indicated that they did not agree or neither agreed nor disagreed were most likely those who felt that, outside of eLCMS, had not used other systems regarded as online or e-learning packages.

Table 5-27: Item 1.1, I have significant expertise in the online and e-learning field

SA	A	N	D	SD	NA
2	7	2	1	0	0

.

Item 1.2 showed that nine of the 12 staff respondents felt that usage of the eLCMS had affected their teaching style (Table 5-28). This result may have been attributable to the immediacy and availability expectation from students in relation to learning content delivery via the eLCMS. The format of the learning materials was another change that long-term members of staff would have had to make in order to work with the eLCMS. The onus was placed on the staff to make teaching files of a reasonable size and quality, leading to issues of standardisation across the school in format and presentation of the learning materials.

Table 5-28: Item 1.2, I find I have had to change my teaching style to fit the eLCMS delivery method

SA	A	N	D	SD	NA
1	8	2	0	0	1

Item 1.3 showed that 25% of staff felt that the eLCMS helped them save time in the management of their unit teaching, while 50% did not (Table 5-29). One staff member thought the statement was not applicable, with two others were undecided. Of the concerns shown by staff that the eLCMS did not necessarily save time in the management of their teaching units, most of the comments were related to features (or lack of) incumbent in the system, the gist of which can be categorised as replication of effort.

Table 5-29: Item 1.3, Using the eLCMS has reduced the time overhead of unit management

SA	A	N	D	SD	NA
1	2	2	4	2	1

Item 1.4 shows that online document delivery was the feature that staff members agreed they used most heavily within the eLCMS, with 100% of respondents in agreement (Table 5-30). Unit messages, whereby messages can be placed within the content delivery system and be automatically emailed to all enrolled students, was the

second most favoured feature, with 83% of staff agreeing that they use this feature heavily.

Table 5-30: Item 1.4, The features of the eLCMS I use most heavily in my teaching include;

	SA	A	N	D	SD	NA
Unit forums	2	3	0	3	2	2
Unit messages	0	10	1	1	0	0
Links to external, web based content	1	6	3	2	0	0
Online document delivery	6	6	0	0	0	0
Online assessment submission	3	5	1	1	2	0

Online assessment submission (by students) would appear to be the third most heavily used feature of the eLCMS, followed by links to WWW content and finally, the unit forums. It is not surprising that the online document delivery feature was the most heavily used as it was the initial reason for the system being created, and as such became the primary method of content delivery to all students within the school. The popularity of the unit messages feature was likely tied into the online document delivery, in that most staff, having placed materials within the eLCMS, then placed a notice within the system using unit messages, informing the students that new materials were available. Online assessments were popular in the fact that, given than an assignment was suitable for electronic submission; it allowed staff members to receive all their student assignments from a single place, with time stamps and logs of the submission. Marked assessments could be uploaded against each electronic assignment submission, placing the onus on the student to then return to the system and download their results. Links to

WWW content was useful for staff to fill out weekly content with current information or external resources, such as software, technical articles or documentation. Unit forums most likely rated the lowest due to the fact that their level of integration with the system (eLCMS) was not high and they did not have the feature set found in commercial forum offerings.

Item 1.5 asked staff to specify the online learning systems they have had previous experience with (Table 5-31). Of the eight staff members to respond, two selected previous experience with WebCT, while another two selected Blackboard. The remaining four respondents selected the *Other* option.

Table 5-31: Item 1.5, Which of the following online learning systems have you used

WebCT	**Blackboard**	**Other**
2	2	4

Of those that select the *Other* option, one staff member indicated that they had previous experience in WebCT, Blackboard, the eLCMS and Plato, the e-learning system with its origins at Control Data and the University of Illinois. One staff member listed Cisco's NetAcad as their previous experience, while another selected an in-house system used within another school outside of the faculty. As these results would indicate, of the eight staff members to respond to item 1.5, only four have used either WebCT or Blackboard, and of the four other participants to list systems, one staff member would seem to have a wider experience with a number of online and e-learning systems. That the amount of experience with online learning systems outside of the eLCMS should be relatively limited was perhaps understandable, as the imperative to move towards reliance on such systems had, at least in the case of the university in question, become apparent only in the last five to six years.

Item 1.6 shows that five staff members agreed that they uploaded all learning materials at the beginning of semester, while seven did not (Table 5-32).

Table 5-32: Item 1.6, I usually place an entire semester worth of materials into the eLCMS at the start of semester

Yes	No
5	7

Those staff who responded yes could have any number of reasons for wishing to make the learning materials available up-front, including catering for the eager students who started working early and move through the content rapidly. In some units, where the content is delivered in an on-campus and online mode, online students gain a great deal of assurance from having most, if not all, of the learning materials available from the first day of semester. The students who studied online and did not have access to the WWW content could receive a cd-rom based version of the materials, the content and interface of this cd matching the online system itself. Obviously, sending weekly updates of such cd-rom based content was inefficient and impractical, so where a unit was delivered in this mode, there was an expectation that a bulk of the content would be ready to go at, or before, the start of semester.

Those staff who responded no to item 1.6 might not have uploaded all materials at the beginning of each semester due to the content being in development, or to keep students focussed on the materials at hand (perhaps as a substitute for sequencing), and to keep students returning to the system.

Item 1.7 covered the week by week uploading of materials to the eLCMS by members of staff, with responses showing that seven members of staff did upload their unit materials on a week by week basis, while five did not (Table 5-33). Again, this may have been due to materials availability or as a very basic form of sequencing, where students were kept focussed on the system (and any unit related messages) waiting on the weekly materials update.

Table 5-33: Item 1.7, I place materials into the eLCMS on a week by week basis

Yes	No
7	5

Item 1.8 demonstrated that half the staff did have students complain about materials availability early in semester (Table 5-34). As previously stated, the eLCMS had created an expectation from students that a bulk of a units content be available early in the semester. This author had on more than one occasion received emails from students on the first day of semester complaining about a corrupted file or typo in a piece of learning content from week 12 of the schedule, literally hours after the unit materials became available. It would seem that at least half the surveyed staff members had similar experiences.

Table 5-34: Item 1-8, I have had students complain to me early in the semester if all the semester materials are not available immediately

Yes	No
6	6

Section one of the online staff survey has indicated that staff felt that they had to change their teaching styles to conform with the requirements of the eLCMS, and that the system did not assist them greatly with the time required to manage their teaching units. The most popular features of the system from a staff perspective were the document delivery capabilities and the asynchronous communications capabilities, in the form of unit messaging. Just under half of the staff uploaded all the content for a semester into the system, while less than half the responding staff had experience with online learning systems outside that of the eLCMS.

5.3.2 Section Two: Most liked features of eLCMS

Staff were presented with the same three blank form fields as the student participants, allowing for unstructured responses regarding the most preferred features of the eLCMS from a staff perspective. Some of the responses fell within the following categories.

Content Management

"unit material delivery" – StaffMember01

"central place for all resources/information(portal)" – StaffMember10

"ease of uploading new materials" - StaffMember11

"Convenient way to provide teaching materials." - StaffMember02

Communication

"Broadcast Messaging" - StaffMember05

"provides students with detailed information about the unit" - StaffMember01

“Convenient way to contact students en masse.” - StaffMember01

Student Driven-Learning

“encourages students to self-learn” - StaffMember01

“accessibility for students, learn in their own time” - StaffMember10

“Week-by-week schedule allows staff to chunk materials to assist students with time management” - StaffMember12

“provides students with several avenues of further/autonomous reading/learning” - StaffMember01

Online Assignment Submissions

“assignment submission” - StaffMember12

“online assessment submission & marking” – StaffMember03

“Online Assessment Feed back” - StaffMember03

The staff responses show a relatively even spread of comments of the four identified categories, with staff appreciating the content management and communication features of the eLCMS, which is hardly surprising as these were two of the primary reasons for the system’s initial development. That comment on the student self-learning aspect of the eLCMS was interesting, with some staff apparently seeing the autonomous nature of the eLCMS as a benefit to students (which for some, it was). The ability for staff to be able to receive student assignments online and to return them via the same medium also received several comments. Looking at the overall trend of comments shown by both the students and staff to the eLCMS system, it seems that the ability to work almost entirely via the WWW, in terms of content, learning and assignment management is paramount.

5.3.3 Section Three: Least liked features of eLCMS

Having had the opportunity to comment on the features they liked most about the eLCMS, staff members were then asked to list the features that they liked least about the system. The two categories presented below represent the two most common themes of the total responses provided by staff.

Workload Concerns

"Two sets of work to put up similar things of undergrad and Grad Dip units" – StaffMember09

"administration overhead" – StaffMember10

"The need to update materials item by item." – StaffMember02

"doesn't solve all the management problems concerned with online delivery" - StaffMember10

Student Related Issues

"discourages students to attend lectures and workshops" – StaffMember04

"the separation of learning outcomes and resources limitations in being able to make it customizable" - StaffMember04

"lack of student tracking" – StaffMember08

"Provide a menu structure for the Schedule page so students access materials on a weekly basis rather than see it all at once - can be daunting" – StaffMember12

Overall there were fewer responses to the negative features of the eLCMS, and a majority of those that were returned showed workload to be the main concern. Having to update the learning materials item by item and the requirement of running two versions of a single unit as separate entities were recurring themes. At least one staff member indicated that they were concerned that the provision of all learning materials on the eLCMS was reducing attendance to weekly classes, while another staff member indicated that they would like to be able track students. This tracking could be in reference to tracking student access to the weekly learning materials. Most of the concerns raised by staff in regards to the eLCMS are technical/design issues that are not necessarily related to teaching practice. However, these concerns are still relevant as they demonstrate how staff would like to use the system to make their teaching more efficient, and one would assume, more effective.

5.3.4 Section Four: Controlled Content Sequencing

Section four of the online staff survey examined staff attitudes to the concept of the CCS system and its possible use as an online content delivery method.

Item 4-1 showed that eight of the staff would like to have students work on learning materials in an order they have decided, while three were undecided (Table 5-35). These responses would indicate that at least some of the staff members would like to have imposed some control over the way in which their students utilised the online learning materials.

Table 5-35: Item 4.1, I would like to have students work on materials in an order I have determined

SA	A	N	D	SD	NA
3	5	3	1	0	0

Staff were asked in item 4.2 if they felt that a combination of features from the eLCMS and the CCS system might provide a better result than using either one or the other, to which two eight staff members agreed (Table 5-36). While the staff were given as much information and possible about the system prior to commencing their survey, no member of staff accessed a demonstration account within the CCS system, so were responding to the staff survey based on the operational and technical descriptions and associated screenshots of the system in operation.

Table 5-36: Item 4.2, I feel that a mixture of the eLCMS delivery method (click what you like) and Controlled Content Sequencing (following a controlled sequence) might be better than using only one or the other

SA	A	N	D	SD	NA
1	7	2	2	0	0

Item 4.3 asked staff about possible student reaction to the CCS system, to which five believed that their students would react positively, while three indicated a negative reaction (Table 5-37). One quarter of the staff members were undecided as to whether their students would react well to CCS system. As the comments section of the staff survey will indicate, many of the concerns staff had about their student reactions to the CCS system centred around the possibility of student complaints.

Table 5-37: Item 4.3, I think students taking my units would react well to controlled content sequencing

SA	**A**	**N**	**D**	**SD**	**NA**
0	5	3	1	2	1

Item 4.4 presented staff with a list of features and mechanisms that could be used in CCS type systems, such as Quizzes / tests and number of attempts at a given task (Table 5-38). The other items on the list are those which were initially intended for integration into the CCS system, but were omitted due to both time restrictions on the system development aspect of the CCS system, and because they were not considered essential to the concepts being tested. All staff agreed that quizzes / tests were appropriate for use in a CCS system, with one quarter of staff respondents strongly agreeing. Given that some staff members have used other systems such as WebCT and Blackboard, it is not surprising that quizzes / tests should be so popular, as such features are built into those systems, thought not necessarily as sequencing or control mechanisms.

Table 5-38: Item 4.4, I believe that the following mechanisms would be appropriate to control sequencing of course content;

	SA	A	N	D	SD	NA
Quizzes / tests	3	9	0	0	0	0
Number of attempts at tasks by a student	1	10	0	1	0	0
Time spent on tasks by a student	0	5	2	4	1	0
displaying / hiding materials according to dates and times	2	7	2	0	1	0
interaction from a member of the teaching staff (such as a confirming that a student has placed a relevant message on a unit forum)	0	5	3	2	0	2

More than half the staff reacted favourably to the option of using a student's number of attempts at a particular task or learning item as a control mechanism within the system.

In response to the option of time spent on task as a control mechanism, five staff members agreed that this measure was appropriate. The amount if time spent on task can be interpreted in different ways by different members of staff. For some, it may mean a control on the minimum amount of time that a student can spend on a certain item before the next one becomes available. Time elapsed on a tasks could be used in the scenario where a participant in the CCS system had failed a section and must attempt it again. If on the second attempt elapsed time was below a certain threshold, measured in seconds or minutes according to particular learning items, the system could alert the user with a message indicating that they should attempt the learning materials 'correctly', then reset the score for that item and require the participant to do it again, similar to that which Darbhamulla and Lawhead (2004b) did in their sequencing implementation. Given that fully one third of the staff members were undecided about time on task as a control mechanism, these same issues might have occurred to those completing the survey.

The option of displaying or hiding content based at certain times or dates refers to making hidden content available, or that visible, but non accessible items could be unlocked (or in the WebCT vernacular, 'released'). This option seemed quite popular with staff, with 75% agreement, with only one respondent strongly disagreeing. Within the eLCMS, if a staff member wanted to make a document available at a certain time, they would either upload it to the system at the desired time, or if it were already there, change the documents states from hidden to visible.

The final option presented to staff as a control mechanism for course content was one where staff would be required to interact with or respond to work that a student had done in order for the student to progress. Only five of staff agreed that this option seemed viable, while two disagreed. A further two staff felt that the option was not applicable. Three staff members were undecided.

It is clear that staff members, given a CCS like environment, were very much in favour of quizzes / tests and number of attempts at task as mechanisms by which to control student progress through a set of learning materials. Time based mechanisms, or those requiring interaction from the staff on a regular basis were rated less practical from a staff point of view.

Item 4.5 asked staff to rate where they could see a system like CCS being most appropriately used (Table 5-39). Five staff agreed with the CCS being used in purely online teaching, while four staff indicated that they disagreed with such usage. Of the remaining respondents, two were undecided and one staff member thought the option to be not applicable.

Table 5-39: Item 4.5, I believe controlled sequencing;

	SA	A	N	D	SD	NA
would be better suited to units delivered in a purely online mode	0	5	2	3	1	1
would be better suited to units delivered in a purely on campus mode	0	2	5	3	1	1
would work well in conjunction with my usual class based teaching activities (lectures/workshops)	2	5	5	0	0	0
would assist my students in their comprehension of the weekly topic(s)	1	8	2	1	0	0

The second option presented to staff asked if they felt the CCS would be suited to purely on-campus units, where there are no online students enrolled. The response to this question was quite empathic, with only two staff agreeing with this option. Five members of staff were undecided, while four staff disagreed with using the system in this way. The attitude of staff to this option was in line with the attitudes of the student treatment group, who also disagreed with the CCS as a content delivery and control tool for on-campus units.

The staff members were a little more positive to the option of a CCS like system being used in conjunction with their normal class based teaching activities, in particular, lectures and workshops. A total of seven staff members agreed with the use of CCS in such a situation, while five staff members were undecided. The final option presented in item 4.5 asked staff if staff felt a system like the CCS would help their students in the area of comprehending the weekly learning topics. Three quarters of staff agreed that the CCS approach could assist in their student's topic comprehension, with two staff members undecided and only one respondent choosing to disagree.

5.3.5 Section Five: CCS Benefits

Staff members were given the opportunity to provide comment on where they perceived the benefits of a CCS like system in the context of learning materials delivery and management. The responses to section five have not be categorised as the content addresses mostly the same issues.

> "ensuring the students have a good enough concept of basic tasks before trying to attempt more complex tasks" – StaffMember04
>
> "Management of online units and monitoring student input/activity would be useful" – StaffMember12
>
> "Helping to ensure that students keep up to date" – StaffMember09
>
> "Measures of student uptake" – StaffMember05
>
> "Flagging system for genuine students that are getting bogged down, not necessarily so obvious in an open classroom of 100 students" – StaffMember07
>
> "Revision of material learnt" - StaffMember09

The staff comments seem to indicate that they see learning uptake and revision of weekly materials are the prime benefits of the CCS system. The ability to be able to track student “input/activity” via a system like the CCS appears to be popular, with the specific capability of being able to identify students who may require extra assistance.

5.3.6 Section Six: CCS Drawbacks

Some of the problems that staff members saw with the use of a CCS approach to content delivery are listed in the following response categories.

Issues with Independent Learning

“not good for developing independent learning” – StaffMember06

“ability for students to scan ahead may be limited” – StaffMember10

“students wishing to do advanced work may be hindered” – StaffMember01

“Students unable to chose their preferred path through the learning” – StaffMember09

Complaints

“Students complaining about workload” – StaffMember08

“students may get frustrated with the controlled structured learning” – StaffMember04

“Students regarding this as excessive testing” – StaffMember09

“annoyance of students, nagging” – StaffMember10

Workload

"extra administration will be required by academic staff" - StaffMember10

"Hugely expensive in terms of preparation" - StaffMember02

"managing it - especially if it requires manual input to say a student can go ahead or not go ahead" - StaffMember11

Several staff had earlier commented the a beneficial feature of the eLCMS was that it promoted independent learning practice by students, while in section six some of those same staff members saw the CCS system as stifling that process. Staff also seemed concerned about the complaints they would receive from students as a result of a CCS content delivery method. It could be that the issue of complaints was linked to the ever-present workload issue, as complaints from students normally entailed more work for staff. The management and preparation overheard required for a system like the CCS was of concern to several staff members, especially the concept of staff having to actively interact with the system as a part of the controlling mechanism.

5.4 Attitudes Summary

Looking at the eLCMS system alone both groups of participants indicated that they liked easy access to content and the ability to work with the materials any time and any place. Students indicated that they did work with the materials in the work they were presented (or before), but that they did not necessarily complete those materials. Some students lamented the lack of self assessment mechanisms being included within the eLCMS, though it must be noted that such comments were mostly generated by the treatment group participants who had already experienced the CCS system. Students from the treatment group responded positively to the structure, content design and assessment features of the CCS system, but seemed concerned with the actual control the system placed on their interaction with the online learning materials.

The online staff survey would appear to indicate that in the case of the eLCMS and CCS systems, staff can see benefits and drawbacks for each. With the eLCMS, staff appreciated the ability to quickly and easily place documents on the system for delivery to students, and felt that the unit based messaging was also an excellent feature with which to keep students informed of changes to the online martials. Staff members were less impressed with the online forums; the expectation from students that all the materials be available early in semester, and that such ready availability of content might affect student's class attendance rates. Staff also indicated that they had to change their teaching styles to work with the eLCMS.

In regards to the CCS system, staff felt that it could offer benefits in the form of content revision and student self-paced learning. Staff members were particularly positive towards the use of quizzes / tests and monitoring the number of attempts at particular tasks by students, though they were less convinced that any kind of staff interaction with sequenced materials could be of value. Staff appeared to couch most of their responses in terms of how their students might react to the various components of the CCS concept, especially in regards to possible concerns from students who preferred to work ahead of schedule, or those who felt they were being treated like children rather than adults.

The survey instruments for the control and treatment student groups provided a clear picture of how students used the eLCMS, and how some of those students reacted to the CCS as opposed to the eLCMS. The survey results, both quantitative and qualitative indicated that the original concern from which this study was developed, namely that students were not interacting with the eLCMS learning materials to maximum effect, was a real phenomenon. Some of the survey data indicated that students did indeed download a bulk of the learning materials at the start of semester, returning to the system only rarely after that. The open-ended questions included in the survey, particularly for the treatment group, proved extremely useful for validating or eliminating perceived patterns and trends in the clickstream usage data. A classic example is the identified issues with fill in the blank questions within the assessments and they fact that the second attempt mechanism was essentially ignored by most of the participants. Finally, the staff responses, again in quantitative and qualitative form were useful in identifying that the purpose and goals of the CCS system had some merit. Interestingly, the staff survey, which was designed largely as a counterpoint to the student treatment group survey, indicated that staff were as concerned about students reacting poorly to the imposed control inherent in the CCS as were the students themselves.

Chapter 6

6.0 General Discussion and Conclusions

This chapter will discuss the findings from this study according to the three central tenets used during the analysis; learning performance, system and content usage and student and staff attitudes towards the use of controlled content sequencing. The concluding section of the chapter will summarise the discussion in the context of the primary research question.

6.1 Learning Performance

> Supporting research question 1: *Is there a measurable difference in student learning performance between those using Controlled Content Sequencing (CCS) and those that do not?*

Both groups showed significant performance gains in their Post-Test results, with the treatment group performing significantly better than the control group. That both randomly assigned groups were presented with essentially the same learning materials indicates that the performance gap between the two groups can be attributed to the format and delivery of those materials. Where the eLCMS contained the normal weekly learning materials to which students had unrestricted access, the CCS system contained segmented and sectionalised versions of the same materials, with access controlled by student performance in multiple online assessments.

These segmented materials were focussed, highly structured and interleaved regularly with assessments related directly to those materials, with end of section review assessments covering all content covered in each section. Treatment group participants were required to achieve specific performance criteria for each section before moving to the next, a second attempt at each section being required should the performance not be adequate to move on. This requirement exposed the treatment group to repeated presentations of the same material, and though the usage statistics showed that participants moved through the content far more quickly on the second attempt, in four of the nine assessments (excluding section reviews) participants showed marginal second attempt improvement. As one participant from the treatment group stated, the CCS content delivery method "made me read the material at least once before printing".

This statement is particularly telling as the initial concept for the CCS came from the perceived problem of students not reading weekly materials as requested, especially if those materials were perceived by students as not being directly related to assignment work. By sectionalising the materials and distributing large pieces of learning content across a number of smaller, more focussed learning items, interleaved with the other materials to be studied, the belief was that students would actually read the materials rather than set them aside for later attention. The assessment items assisted in this as it would appear that students did work with the materials in order to do well on the assessments, at least on the first attempt at any given section. This finding is consistent with the literature which indicates that the use of quizzes or assessments tied to reading activities can encourage students to address course materials more conscientiously, with Presby (2001) using quizzes (linked to course credit) associated with textbooks readings as such a mechanism.

The issue of the CCS and reading was of some importance to another treatment group participant who stated that

> “Pre-test, it is the worst part. It is better to replace to tip [sic], ask the reader what to get from the Read Assessment. Ask the reader to take note of what part in the power point or extra reading document” and that “The section of the lecture have divided up to three part. It make the read feel that it is too much to read”. – User48

As stated previously, this participant had English as a Second Language hence the somewhat broken English in his response. Two key issues are raised by this participant, both of which relate to the perceived problem of students not wishing to read all the materials they were presented with. In the first statement, the student appears to be saying that rather than be asked to read an entire document and be tested on it, he would like the system to point him to the important parts, those parts upon which he was going to be assessed. This researcher has experienced countless conversations with students along similar lines, where a student asks ‘which bit’ of a reading, workshop or lecture they should look at, a situation experienced by other instructors using online systems. An online discussion between users of e-learning systems revealed that student attitudes were essentially “I need an instructor to tell me what to do/think/know” (elearnspace, 2002) when presented with unstructured learning materials which the students were expected to ‘explore’. The requirement to ‘explore’ online materials without an instructor to provide direct guidance led to students experiencing “ambiguity of exploration”, where learners wanted to know what to read and to what effect, rather than have to read and comprehend all the content. The same types of conversations occurred at the end of semester for this researcher, where students wanted to know which part of the syllabus to focus their exam preparation on. Examples from the literature would indicate that this is not an uncommon situation, with Lundquist (2001, p. 1177) having similar experiences

> “In a course with a final exam, students often tend to spend a great deal of their efforts rather late in the course preparing for this exam. When sorting out new

concepts depend on time and reflection, which clearly is the case in our statistics course, it would be better if students were more active earlier in the course."

In the second statement from User48, the participant was concerned that the sectionalised approach to the learning materials created too much reading across the week three materials. It is interesting that not one participant from the control group using the eLCMS made any comment regarding the amount of reading, or the amount of work required for any of the week three learning materials. Yet for User48 and other members of the treatment group the amount of work required of them, reading in particular, was a recurring theme. Given that the 'amount' of learning materials for both groups was the same, not including the assessment items, it appeared that when required to actually complete the materials, due largely to the control imposed by the CCS system, participants in the treatment group saw the necessity to read everything as a concern. However, it would appear that by interacting with all of the weekly learning materials (instead of select items) and completing those materials over a longer period of time, the performance of the treatment group was consequently higher than that of the control group, the latter being able to selectively study the week three materials with no requirement for completion.

This study has repeatedly made reference to the concept of proximity in relation to students and online learning materials, with proximity relating to the amount of time (and effort) a student dedicates to prescribed learning materials. The performance results for the control versus the treatment group shows that a higher level of interaction between students and learning materials, to a measurable degree (i.e. the use of assessments) leads to better student learning outcomes. Whilst most educators and instructors may find this to be an obvious conclusion to draw, this author feels that literature in the field of e-learning and online learning is under developed when examining the issues of students working with and using their learning materials as opposed to simply having access to them. Delivering learning is different to requiring learning, and it is the assertion of this research that both these factors need to be addressed and integrated if the online support of existing teaching practices (such as on-campus teaching in this case) is to have educational merit.

6.2 System Usage

Supporting research question 2: *What affect does Controlled Content Sequencing have on student usage of online learning materials?*

Participants in the treatment group went from using a student centred content delivery system in the eLCMS that allowed them to access learning materials at any time and in any order they wished, to using the CCS system which controlled both the access and the order. The treatment group usage of the CCS system gave an interesting insight into the types of 'study' patterns students developed when using a controlled access model. The usage patterns for the control group were used as a guide by which typical usage of the eLCMS and learning materials could be defined.

To provide some background regarding the evolution of learning content delivery within the school in question, students initially received printed workshop sheets at the beginning of a workshop from the lecturer/tutor. Printed copies of the weekly lecture slides would be placed in a public filing cabinet listed by unit so that students could borrow them, photocopy and replace them (or not) for others to use. Lists of recommended or required readings would be given out at the beginning of semester, with the onus on students to complete the readings each week. Aside from workshop attendances, which could be estimated by counting the number of printed workshop sheets remaining at the end of each class, staff had very little idea how students were working with the materials. The situation was similar with the eLCMS, with staff being able see students working through materials in class (usually workshops), but to have little or no control over how students were utilising their weekly learning content. As discussed earlier, one outcome of the eLCMS was that some students, seeing the content delivered completely online, translated their study habits to be mostly online, particularly given that the classroom was no longer a distribution point for weekly materials. As 30 year teaching veteran Jim Berger states in (Chabonneau, 2005)

> “the online component is a very important part of the course, but some students treat it solely as an online course and don't attend the in-class meetings.

Berger’s statement is particularly relevant to this research, in that some students need the structure of class contact, or at the very least, contact with the learning materials. Presented with the option of not being involved with the learning process, and only selectively involved with the learning materials, students can fall into poor study habits that can eventually limit their learning outcomes (from a unit perspective at least). For those students with poor self regulated learning strategies, environments of choice can allow for poor choices (D. Young & Ley, 2003; J. Young, 1996).

Four distinctive study styles were identified within the treatment group’s clickstream data, related directly to the concept of most and least resistance, primarily in obtaining the learning materials from within the system.

1) The ‘hunt and peck’ study method

This term described the behaviour of those treatment group participants who consistently clicked back and forth between learning items and associated assessments. Though assumptions were made about what this behaviour implied, the most likely explanation was that participants were using the find function (Ctrl + F) within the PDF documents to search for terms relating to the questions in the assessments. The reading materials attracted the lowest average times on task of the three types of learning materials, but also appeared to be the learning items at which participants performed the best, though this was thought to be as a result of the proximity of the reading materials to the lecture materials, both of which covered the same topics only in varying depth.

2) The 'click and run' study method

This describes the actions of those participants who moved through their second attempt at failed sections with great speed. The treatment group participants were not informed that the CCS system incorporated a multiple attempts mechanism with a set limit of two attempts per section. The second attempt completion data showed a reduction in working time from hours on each item to just minutes. Once participants became aware of the two attempt limit (after section one) the already low working times dropped even further. The second attempt mechanism was included as a revise and review opportunity for students to better their performance on a given section of content. However, the actual effect was the opposite, with students moving through the second attempt materials at high speed, a result supported by the following participant statement.

> "In section 2 I went to go through the entire thing with blank answers just to go back to the start, before I realised there was an attempts limit and couldn't go back and redo it, hence the default answers for everything in section 2". -User38

This addresses a number of issues relating to both the design of the two-attempt mechanism and of student study attitudes. A recurring concern for students was that the CCS system did not identify correct and incorrect answers after each assessment, only presenting students with a score for each assessment. The design decisions as to why the answers were not provided have been discussed, and at this point it would seem more pertinent to consider whether participant usage of and attitude towards the second attempt mechanism would have been different had answers been provided. For this study, participants raced through the second attempt in order to get to the next section of content, realising that their score on the second attempt would not preclude them moving on. If incorrect answers were identified on the first attempt for each assessment, it seems likely that some students would record this information, and simply change those specific answers on the second attempt, hoping to improve their score. However, given that an attempt limit was still in place, it seems unlikely that students (given the attitudes expressed already) would actually strive to perform better, unless they needed to do so to progress through the system. In another scenario, if students were provided with answers on the second attempt at a section, it could be that a reverse usage pattern appeared, where students would race through a section leaving blank or default responses, in order to get the answers during the second attempt. Again, Lundquist (2001, p. 1177) has encountered similar situations, where the answer is the student goal, not the accumulation of knowledge that leads to an answer;

> "Furthermore, there often seems to be a heavy emphasis on getting the right answer rather on learning from mistakes which from a constructivist viewpoint seems more desirable."

As stated earlier, the CCS system was initially going to be designed so that one or more of the sections would require participants to keep repeating until they passed a section, with no attempt limit being set. Though this was not implemented in the main study due to the concern of increased abandonment rates for the study, it would certainly have produced some interesting data as to whether the second attempt (or more) working times would have increased if the participants had to pass the section to progress.

3) If at first you don't succeed….

One of the most perplexing usage patterns to emerge from the clickstream data was that showing a number of treatment group participants submitting assessment items, receiving their score, then clicking the browser Back button and attempting to re-submit the same assessment with different answers. The fact that some participants would try to do this is of course no surprise, as what student would not wish to be able to instantly re-sit an exam upon finding out they did not perform well the first time. Winslow (2001, p. 1236) reported this very effect when studying students' 'cheating' abilities with online quizzes, noting that "the most common method used by 61% of all participants was to retake the quiz over and over until the desired score was achieved". Unlike Winslow's quiz system, the assessments within the CCS system would not accept multiple submissions, a fact that was clearly indicated in the form of a polite message to any participant attempting to do so. The surprise came in the realisation that some participants persisted with the tactic throughout the entire set of CCS materials. Not only were students given a polite message indicating that they had already submitted an assessment for a given item, but the progress and score sheet for each completed item was displayed either during the login process or during transitions between sections. User38 described this feature; "It was set once you do it [sic] you can't change your result unless the whole section is done not giving another chance to go back and re-do".

4) Drawing a blank

An examination of the way in which participants answered their assessment items made it very clear that "fill in the blank" questions were not popular. Throughout the CCS materials, "fill in the blank" questions were left blank either as a matter of course, or on the second attempt at a section. Of the 26 instances of questions being left blank on either the first or second attempt at a section, 25 of these questions were "fill in the blank".

Written feedback from participants regarding the fill in the blank questions left little doubt as to the reason for these questions being left unanswered, with User39 stating that "answers that have to be typed in too hard to get right as different meanings for answers". User57 also complained that "When entering answer in review, a textfield did not allow me to enter correct answer - i.e. did not allow correct number of letters (question what OSI acronym stood for - I tried to enter Open System Interconnection but it wouldn't let me put in the last letter". While the answer to the question User57 was concerned about was actually Open Systems Interconnect, the answer provided by User57 was a common variant of the desired answer. It is true that fill in the blank style questions did allow for misinterpretation and incorrectly formatted answers, but in this case, it was hoped that if one variant of an answer did not fit, the participant would expand their reading/searching further to find one that did fit. The reverse of this turned out to be the case, with participants attempting to shoehorn their answers in, even if it meant leaving letters off the end of their answers or removing spaces between words. Participants also changed capitalisation of words on second attempts at fill in the blank style questions, obviously believing that the system was case sensitive.

In case of the above example, it was thought that if a participant could not readily locate an answer that fitted the available field length that they would go to outside sources (primarily the WWW) and find various iterations of each of the terms until they found the most likely candidate. This concept was not dissimilar to the system De Bra (2004) describes, which instead of providing answers, provided links to materials where the answers could be found. Given the attitudes towards the second attempt mechanism by participants and their attempts at multiple submissions of assessment items, it is doubtful that students would have looked at external resources even if they had been directed to them (except perhaps for the following participant).

> "questions were a little pedantic at times ! perhaps hints or referrals to material as you answer them ?" – User43.

Student usage of the CCS system indicated that students were willing to work their way through the CCS materials at a steady pace and spend what could be deemed a useful amount of time interacting with the learning materials, on the first attempt at each section at least. As stated earlier in the study, it is impossible to know exactly to what level students in the treatment group interacted with the CCS materials once they were downloaded from the server, though the clickstream data does give some indication according to clicks per item. Student reaction to having to work through a section of material a second time appeared far less thoughtful, with nearly all participants racing through the second attempt at high speed, solely for the purpose of progressing to the next section of learning materials. It is interesting to note that even though most students within the treatment group became aware of the two attempt try limit as of section one, those students still put in similar working times on attempt one of sections two and three, rather than also racing through attempts one and two in order to move on and gain access to all the learning materials more quickly. This could be a result of the student participants seeing the first attempt at any given section as being valuable to their learning, but seeing the second attempt as merely a hindrance, having no intrinsic learning advantage.

6.3 Attitudes

Supporting question 3: *What design attributes and implementation factors affect student and staff reaction to Controlled Content Sequencing?*

While the chapter thus far has focussed on the measurable benefit that participants gained from using the CCS system and how they interacted with it, the attitudes of students and staff to both the concepts and implementation of the CCS system will be examined, leading into the concluding discussion of the primary research question.

6.3.1 Student Attitudes

The student attitudes gathered from the student survey, when examined in the light of performance and usage data discussed previously, indicate that students like the structure of the CCS system and the assessments, but do not like the overlay of control that these features provide when linked to the CCS rule-system. Some of the positive comments related to the assessments included the following;

> "feedback given as to progress/understanding" – User43
>
> "it indicates your strengths and weakness for that week" – User64
>
> "the quiz at the end of each section is beneficial for student feedback on progress" – User54
>
> "I like the idea of read first and get question later." – User48

These comments show that participants appreciated the progress tracking and feedback features of the CCS system, including the score-specific messages displayed to each participant after completing an assessment, as well as the score placed against each completed item. These particular participants seemed slightly less concerned that they were not receiving the assessment answers, but that they were at least getting an indication as to their performance at certain materials, materials which they could focus more effort on at a later date. The above participant responses indicate that the assessments within the CCS system offered more than just right or wrong answers, rather tools by which students could assess their own level of concept understanding. However, of the five participants quoted above, three did also identify negative issues regarding the assessment; these concerns (which have been cited previously) were primarily to do with the difficulty of the assessments and not receiving the answers.

The structure of the CCS system and the re-authoring of the original learning materials into smaller, more discrete ‘chunks’ also received a number of positive responses from the treatment group participants.

> “Separates lectures/readings/workshops into logical sections studying the same thing” – User38
>
> “paced delivery - could see what you were supposed to be doing at each stage” – User43
>
> “It's necessary to understand one section before moving to the next.” – User59
>
> “have to complete other topics before start new ones” – User39

These responses indicate that the efforts put into the system structure and the content within were not in vain, and that the treatment group participants appreciated the highly structured CCS approach. Even User38, an ardent critic of the CCS system, showed approval of the structure and content of the system, if not the control mechanisms. Given the positive response to the CCS structure, the responses from sections five and six of the treatment group survey, most and least liked features, were examined to ascertain whether structure or content was raised as an issue for the eLCMS. Some of the ‘liked least’ responses from participants of the eLCMS included;

> “Very little ability to check your understanding” and “Too easy to ignore/miss important materials”– User59
>
> “the whole lecture in one section which sometimes make it boring to just sit and read” – User67
>
> “schedule page is cluttered, unorganized” – User64

"it doesn't record what you have completed" – User74

From these responses it is apparent that participants were already mentally comparing the eLCMS content delivery method against the CCS method they had just experienced, and that once again content and structure were paramount to their thinking. The response from User59 referring to the eLCMS not allowing participants to check their understanding was common in section six of the survey, indicating that the lack of an assessment/quiz mechanism within the eLCMS stands out as a glaring omission from the student perspective. However, given that section five of the survey, 'most-liked' features of the eLCMS, was almost entirely related to accessibility and being able to download any item at any time, this contrast with section six would again suggest that whereas structure and assessment were welcomed by students, the application of control was not.

While the structure and assessments were important to participants in the study, the format of the learning materials that were stored within that structure was also important from the student point of view. As a result of issues raised within the pilot study concerning the media formats used within the initial CCS system, a standard document type was adopted for all materials within the main study version of the CCS system. The media formats used in the pilot study saw the original Microsoft PowerPoint™ slides converted to HTML, with the readings being HTML and the workshop files converted from Microsoft Word to PDF. Though students found the HTML versions of the lectures and readings easy to navigate, they were not well suited to downloading or printing. This is supported by the recommendations of Burt (2004), in his discussion of the benefits of the PDF format in related to e-learning guidelines.

"Think about your end users when deciding to provide information in any format other than a HTML. Microsoft Office documents often have large file sizes illsuited to web transmission and can display inconsistently across different computers. Long documents are ideally suited to Portable Document Format (PDF)."

Even Burt recommends HTML as the default for media files, with PDF being the alternate to proprietary formats, however this reference to HTML does not take into account how online learners are going to utilise the online materials. In the case of this study it appears that participants downloaded the materials to their local machines, and then printed those materials. In the first iteration of the CCS system, this practice would have been difficult as saving HTML files to a local machine requires large number of smaller files (such as images) to be downloaded and stored alongside the actual written text of the page. Given that HTML documents are designed to render text and images to screen rather than to print, "printing often seems to be the bane of web publishing doesn't it? All this information scattered across the 'net, and so many times, trying to get a decent hardcopy printout just results in frustration" (Hanscom, 2003).

To avoid these issues in the main study all materials were converted to PDF, which had the benefit of retaining the original colours, fonts and formatting and ensuring that, regardless of the hardware/operating system platform used by the participants, they would be able to see the learning materials as they originally appeared.

In the CCS system these PDF documents were displayed in the main presentation frame, which accounted for approximately 70% of the CCS interface area. Some participants indicated that the PDF documents, when loaded into the CCS system presentation frame were too small to read and that they had to print them out to study them. This was an issue that varied from participant to participant dependent on the visual resolution of the machine upon which they were working. With the conversion of all the learning materials to PDF, where participants found screen size and subsequent text size to be an issue, they could then download the content and manipulate it locally, a process aided by the menu items that accompanied each PDF document loaded in the WWW browser (see Figure 6-1).

Figure 6-1: PDF documents toolbar in WWW browser window

Though the ability to download and read/print the PDF documents locally was more flexible than the HTML, some participants still mentioned it as a problem when responding to the CCS system;

> "having to save the material into a file and opening again using Adobe so it could be resized." – User60

The issue of media formats is a difficult one to solve with any particular technology, given that different students will have differing study habits and particular preferences for media types. Those students preferring to read materials online would probably not care as much about downloading and printing issues, thus HTML would be an acceptable format. For those wishing to download and print learning materials, the format is of greater importance as it dictates how easy or how difficult that process turns out to be. Within this study, the PDF version of materials generated less student angst than in the pilot study where more than one media format was used.

The overall student attitude to the CCS system used by the treatment group could be defined as mostly positive, in that most of the features of the system were well received, with the exception of the actual control. This conclusion is drawn from sections seven and eight of the student survey, as examined in the previous chapter. The last question of the survey asked participants the following;

Item 8.4: *I would like to see a system like the CCS used in my other units*

To the item 8.4 statement, 42% of participants agreed, with 47% neither agreeing nor disagreeing. Only 11% of participants disagreed that they would like to see the CCS system adopted in their other units of study. The reason that nearly half the participants chose to neither agree nor disagree most likely stems from participants wanting most, but not all of the CCS control mechanisms to be adopted in any possible future use of the system. The responses to the items 8.2 and 8.3 from the student survey support this conclusion, with 79% and 86% agreement for these two statements from the treatment group participants.

Item 8.2: *I feel a mixture of eLCMS and CCS content delivery methods would be beneficial*

Item 8.3: *I prefer to download all the materials and work on them at my own pace and in the sequence I feel comfortable with*

The 'mixture' of eLCMS and CCS methods, at least to the student mind, most likely entails the conclusion that has already been drawn, that structure and assessments should stay, while control of content access should go. This statement was reinforced with the high level of agreement to item 8.3. This author believes that it is indeed the control aspect of the CCS, in conjunction with the assessments and content structuring that promotes improved learning performance those students using the system. Without the control mechanisms to enforce the sequencing of content access, based on a minimum standard of ongoing learning performance, the author believes that the results for a 'mixed method' approach to the CCS would be little different to the eLCMS learning performance results. Controlled Content Sequencing without control would be little more than the eLCMS with improved content structure and design.

While it can be concluded that the control is the single element which most participants would like to see removed from the CCS system, integral as it might have been, the question remains whether this attitude might have been different were the treatment group members aware that they had performed better using this system. While the reasons for this mechanism not being in place was examined in Chapter 3, the acceptance level of the CCS system, including the control mechanisms, might have been higher had students been able to see the tangible outcomes of using the system.

6.3.2 Staff Attitudes

Unlike the student participants in this study, staff members appeared less interested in the structure of the CCS system as they were in the control elements, particularly the assessments. Two thirds of the surveyed staff indicated that they would like students to work on the materials in an order they have determined optimal, with all staff agreeing that assessments would be ideal control mechanisms, followed by the number of attempts at a given task by students, with 91% staff agreement. Three quarters of the staff felt that the CCS system would assist their students in comprehending learning materials, though just less than half felt that their students would not readily accept the CCS approach to content delivery.

From the responses received from the staff survey, four main perspectives emerged relating to the concepts involved in the CCS. These were classified as two main drawbacks and two main benefits.

Drawbacks

1) Workload

2) Student complaints

Benefits

1) Student revision/concept fundamentals

2) Student monitoring

Staff were concerned about workload in regards to the eLCMS, and that time savings gained in some areas from the use of the system were offset by time penalties in other areas (such as duplication of effort). Upon receiving an in-depth description of the CCS system, staff indicated that their first concern was that the workload required to re-author the learning materials and design the associated assessment would be "hugely expensive in terms of preparation". One staff member commented that "extra administration will be required by academic staff", while another simply said "more effort". Staff concern regarding the administration of the CCS system was legitimate, as the initial effort required to re-author the learning materials effectively and to create the assessment would be more than that required to place a semester of learning materials within the eLCMS. However, the question that arises is whether, once established, a semester of content delivered via a CCS method would reduce overall workload due to improved student performance, leading to less administration of assignment extensions and student tutoring outside of normal class times (to assist students to catch-up). However, given the second concern of staff, student complaints, it could be that staff would see the benefits of lower student administration overheads as being offset by the complaints they would receive from students being ‘forced’ to work with all the learning materials within a unit. One staff member commented that “students will complain. They like to see the whole of the course - it is a comfort factor knowing what you are in for”, while another felt that “students may get frustrated with the controlled structured learning”. Other staff comments included “annoyance of students, nagging” and that “students complaining about workload”, this latter statement reflecting the concern of some of the students from the treatment group.

Building on the discussion of student complaints, some staff members were concerned that the control mechanism of the CCS system would be interpreted as being too remedial by high performance students, and that such students would be held back by the nature of the content delivery. However, as Young (1996) and Zimmerman and Martinez-Pons (1990) indicated in their research, high performance students still perform well within a program controlled environment, they will just not receive the same amount of benefit as would lower performance students. It is for this reason that some of the adaptive systems discussed in Chapter 2 use pre-test items before students begin a course of study, so as to classify students according to what they know and what they do not. Once the student’s existing domain knowledge has been established, a customised course of learning content can be created, specifically tailored to a given student’s requirements. In regards to the CCS system, a different approach is envisaged to address the issue of high performance students using such a controlled environment. If the CCS system were to be used to deliver an entire semester’s worth of learning materials, additional rules could be encoded into the system that would examine each student’s ongoing cumulative score for each progressive week. If the student were found to be achieving a certain level of performance, such as passing all sections on the first attempt for the first few weeks of semester, then the student could automatically be offered the option of the control elements of the system being deactivated. The sequence of materials and the assessments would remain the same, but the student could go to any section of material in any part of any week of learning. Each unit author could set their own level of performance at which such an option would be made available, or as with the adaptive systems featured in Chapter 2, the activation of this function could be as the result of a unit pre-test. Again, how and when such an approach would be implemented would require careful investigation, for as stated previously, CCS without the control is unlikely to impact upon student learning performance.

Looking at where staff perceived the benefits of the CCS system, student revision received several comments, including “good for poor or repeating students”, “Revision of material learnt” and “ensuring the students have a good enough concept of basic tasks before trying to attempt more complex tasks”. These comments from staff reflect the very reason for the CCS system development, to ensure that students are exposed to all the concepts within their learning materials, rather than have some students address only certain parts of the syllabus. One staff member felt that the CCS would be particularly well suited to “technical procedures/functionalities i.e firewall ruleset, scripts, rulesets”, which is an accurate reflection of the type of materials presented to students within this study. The CCS system evolved to address teaching issues related to online materials utilisation within a school of computing and information science, where procedural, step-wise instruction is apparent in a majority of the teaching process. How the CCS would perform as a content delivery system in a more conceptually driven environment was outside the scope of this research, but would certainly make for interesting comparisons of content development, student performance, usage and attitudes.

Staff saw “monitoring student progress” within the CCS system as the second main benefit that the system could offer, with monitoring describing both usage and performance. In support of this statement, one staff member saw the clickstream data within the CCS system beneficial to “Locating student problems with the material”, this statement indicated that the staff member would re-evaluate any learning materials in which a majority of participants performed poorly. Another staff member stated that “management of online units and monitoring student input/activity would be useful”, indicating that some staff are as interested in how students were using the learning materials as well as how they were performing with those materials. In a situation where a student requests extra assistance with learning materials, workshops being the prime example, the ability to examine how they had accessed the materials up until the point of requesting assistance could be extremely useful as a feedback and instruction method. If the student had shown an infrequent login pattern, or had spent little time working on the materials, they could be directed to try again, and to come back when they had spent more time with the materials, or had achieved a particular score in the assessments, which could have the outcome of "helping to ensuring that students keep up to date". These comments by staff indicate a desire to be able to monitor student usage of materials, monitor the effectiveness of those materials and to gain "measures of student uptake" of the materials, with the CCS clickstream data working as a "flagging system for genuine students that are getting bogged down, not necessarily so obvious in an open classroom of 100 students".

While staff members were largely receptive of the CCS system and its goals, they were concerned that students would complain about the system and that the system would require excessive time overhead to manage. However, as with the treatment group participants, staff members were not informed of the significant performance increase shown for those students using the CCS system as compared with the eLCMS, and may have been more positive once the benefits were observed.

6.4 Main Research Question Conclusion

Would controlled content sequencing be a useful delivery method for web-based university learning materials?

Examining the main research question from a performance perspective, there is little doubt that Controlled Content Sequencing was useful in terms of providing a significant learning edge for those participants using the system as compared to those that did not. The four factors within the CCS design that contributed to this performance outcome are control, assessments, structure and content design. While each of these factors undoubtedly played a role in the performance results for the treatment group participants, it is the control aspect that is attributed as having the most important contribution. The clickstream data for the participants indicates that most materials received several hours of working time (aside from the readings), while the unstructured responses from students indicate that this working time was not the norm. Without the control in place, it seems likely that students, even with the added structure, focussed materials and content-specific assessments, would have reverted to a selective utilisation of learning materials approach. By requiring students to work through the materials in order to allow them to pass the assessments, so that they did not need to repeat the sections, the CCS system created an environment where students saw all materials and showed higher content retention than those who were not so 'controlled'. Students found most aspects of the CCS system to be useful, such as the central functions of assessments, structure and content, but were not as receptive to the concept of controlled content access

Staff members were receptive to the concepts of the CCS system, indicating that they would like the ability to require students to work on learning materials in a sequence set by them. Assessments and number of attempts were the control items deemed by staff as being most useful within the context of controlling content access and delivery. Staff members were especially interested in monitoring their students, to both identify the competency of students on an ongoing basis and to ensure that the learning materials were effective and relevant. However, though most staff members indicated that they would like to use the CCS, their enthusiasm was curbed by the concern that students would complain about and rally against control being placed on their access to and use of the online learning materials

6.5 Implications for Practice

The results of this study indicate that even though students may not like being made to work with learning materials in a predetermined sequence, and show proficiency with those materials, the results for those students will be beneficial. The results of this study are particularly relevant to academic staff members in university and college environments where the WWW has evolved as the primary delivery medium for learning content. In such situations, educators should be aware that high content availability and accessibility, while appreciated by students, will not necessarily translate into effective utilisation of those learning materials. This concern is shared by Shepherd (2003), stating that "Hard experience demonstrates that the average learner finds it hard to impose a timetable upon themselves and stick to it". Placing elements of control on access by students to these online learning materials will result in higher levels of proximity between the students and the actual informational content of the materials. Content-specific assessments offer the easiest and most reliable measure of student comprehension of the learning materials, and when tied to content accessibility, will inculcate in students the concept of progress through materials being related to performance within those same materials.

Effort in structuring and refining learning materials is rewarded, particularly from a student attitude perspective. The results of this study and others show that students, regardless of attitude to controlled learning, do appreciate logically structured environments, containing content designed specifically to fit within those structures (Brusilovsky, 1999; Brusilovsky et al., 1996; Brusilovsky & Vassileva, 2003). Monitoring of student usage and performance within learning materials provides online teaching staff with a powerful tool to identify student learning problems, both individually and at the class level, allowing for rapid changes to content and teaching structures to overcome such problems (Mazza & Dimitrova, 2004).

Finally, if mechanisms of control are to be used within the context of learning content delivery, students should be informed of why the control is being applied. It seems likely that had students in this study been more fully informed of exactly why the control element of the CCS system had been developed, their attitudes towards that control may have been more positive, as it was with the other elements of the system. However, as deeper explanation of the research aims might have created bias in the data collection instruments used in this research, such a detailed explanation was not given. If students understand that a control mechanism has been put in place to ensure their use of learning materials, and not as some type of perverse academic punishment, then perhaps they might use such a system with performance benefit, not time expedient, in mind.

6.6 Recommendations for further study

Within the context of this study, more work is needed on the remedial content delivery approach (repeated exposure to same content), as the second attempt mechanism used within the CCS system did not have the desired effect. Instead of students studying the materials in greater depth having failed their first attempt at any given section, students raced through the materials without reading them, with second performance scores indicative of this haste. A middle ground is sought between the complexity of expert-system driven adaptive learning environments (including their design and content authoring requirements), which could present students with remedial content and assessments adjusted to their dynamically changing student model, and the fully student driven systems where students can access any content in any sequence, regardless of ongoing assessment or quiz performance. This middle ground could see the multiple attempt model adjusted so students are required to repeat a section as many times as necessary to achieve a passing score. Student performance and attitudes to such an approach could then be compared to those identified in this study. Integrating the work of Tang and McCalla (2003), the second (or multiple) attempt mechanism within the CCS could be expanded to include a content recommendation function, for example where students were directed to an external website, to conduct further research, and to find answers.

Given that the CCS system improved student performance, and that staff were receptive to controlling student use of online learning materials, further research into a course authoring interface for the CCS system, allowing staff to define their own rules of progress would seem worthwhile. Taking this further, research into different types of control measures, aside from assessment scores and attempt limits, could also be useful. This line of inquiry seems especially relevant given the ongoing development and acceptance of sequencing technologies in e-learning, with the IMS Simple Sequencing model being a prime example. As Learning Objects are now being integrated into mainstream VLE's, such as WebCT and Blackboard, it may be that in the coming years a demand will arise for Sequencing Objects to be used in a similar manner.

6.7 Conclusion

This research examined the use of controlled content delivery and sequencing, examining whether such features would be useful within the context of a university online teaching environment. Specifically, would students using a rule driven system for online content delivery perform better than those who did not use the system, and how would it affect their usage of that system. These questions were addressed through the use of a number of research instruments aimed at collecting data from students and staff, the primary stakeholders in the content authoring and delivery process.

The outcomes of this study provide a roadmap for e-learning and online learning developers and researchers wishing to give content authors and educators more control over how online learning materials are accessed and utilised by their students. Control, structure, content design and assessments are all critical to student performance, with control being the factor that separates good student performance from excellent student performance.

This research should provide educators and instructors in the online environment with the confidence to apply control over how their students use WWW-based learning materials, with the knowledge that such control, when linked with good structure and content design, will provide tangible student performance results.

> "Tell me and I forget. Show me and I remember. Involve me and I understand."
>
> \- *Anonymous Chinese Proverb*

References

Abdullah, N., & Davis, H. (2003). Is simple sequencing simple adaptive hypermedia? In *Proceedings of the fourteenth ACM conference on Hypertext and hypermedia* (pp. 172-173). Nottingham, UK: ACM Press.

ADLNet. (2004a). *SCORM: Sharable Content Object Reference Model*, from http://www.adlnet.org/index.cfm?fuseaction=DownFile&libid=648&bc=false

ADLNet. (2004b). *Sharable Content Object Reference Model (SCORM) 2004 2nd Edition Overview*. Retrieved March 6, 2005, from http://www.adlnet.org/index.cfm?fuseaction=DownFile&libid=648&bc=false

Ainsworth, S., & Grimshaw, S. (2002). *Evaluating the effectiveness and efficiency of the REDEEM Intelligent Tutoring System authoring tool* (No. 69): University of Nottingham.

Akscyn, R., McCracken, D., & Yoder, E. (1988). KMS: a distributed hypermedia system for managing knowledge in organizations. *Commun. ACM, 31*(7), 820-835.

Akscyn, R., Yode, E., & McCracken, D. (1988). The data model is the heart of interface design. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 115-120). Washington, D.C., United States: ACM Press.

Alexander, S., Kandlbinder, P., Howson, E., Lukito, L., Francois, A., & Housego, S. (2002). *Simassessment: enhancing academics' understanding of assessment through computer simulation.* Paper presented at the Proceedings of the 19th Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education.

Anane, R., Crowther, S., Beadle, J., & Theodoropoulos, G. (2004, August 30 - September 03). *eLearning content provision.* Paper presented at the Database and Expert Systems Applications, 15th International Workshop on (DEXA'04).

Andersen, J., Giversen, A., Jensen, A., Larsen, R., Pedersen, T., & Skyt, J. (2000). Analyzing clickstreams using subsessions. In *Proceedings of the 3rd ACM international workshop on Data warehousing and OLAP* (pp. 25-32). McLean, Virginia, United States: ACM Press.

Anderson, L., & Burns, R. (1989). *Research in classrooms : the study of teachers, teaching, and instruction*. Oxford, England ; New York: Pergamon Press.

Angehrn, A., Nabeth, T., & Roda, C. (2001). *Towards personalised, socially aware and active e-learning systems*

Angelides, M., & Paul, R. (1993). Towards a framework for integrating intelligent tutoring systems and gaming-simulation. In *Proceedings of the 25th conference on Winter simulation* (pp. 1281-1289). Los Angeles, California, United States: ACM Press.

Ardito, C., De Marsico, M., Lanzilotti, R., Levialdi, S., Roselli, T., Rossano, V., et al. (2004). Usability of E-learning tools. In *Proceedings of the working conference on Advanced visual interfaces* (pp. 80-84). Gallipoli, Italy: ACM Press.

Arruarte, A., Fernandez-Castro, I., Ferrero, B., & Greer, J. (1997). The IRIS Shell: how to build ITSs from pedagogical and design requisites. *International Journal of Artificial Intelligence in Education, 8*, 341-381.

ATRC. (2005). *ATutor: Learning Content Management System*. Retrieved 21/05/2005, 2005, from http://www.atutor.ca/

Baldoni, M., Baroglio, C., Henze, N., & Patti, V. (2002). *Setting up a framework for comparing adaptive educational hypermedia: first steps and application on curriculum sequencing*. Paper presented at the ABIS-Workshop 2002: Personalization for the mobile world, Hannover, Germany.

Barre, V., Choquet, C., Corbiere, A., & Iksal, S. (2004, August 30 - September 01). *Usage Analysis in an e-Learning System: LD Representation Significance.* Paper presented at the IEEE International Conference on Advanced Learning Technologies (ICALT'04), Joensuu, Finland.

Benson, A., Guy, T., & Tallman, J. (2001). Viewing Online Learning through the Lens of Perspective Transformation. *International Journal of Educational Telecommunications, 7*(1), 251-269.

Bergstedt, S., Wiegreffe, S., Wittmann, J., & Möller, D. (2003, July). *Content management systems and e-learning-systems - a symbiosis?* Paper presented at the The 3rd IEEE International Conference on Advanced Learning Technologies (ICALT'03), Athens, Greece.

Bleek, W., & Jackewitz, I. (2004, January 05 - 08). *Providing an E-Learning platform in a university context - balancing the organisational frame for application service providing.* Paper presented at the Proceedings of the 37th Annual Hawaii International Conference on System Sciences (HICSS'04), Hawaii.

Blessing, S. (1997). A programming by demonstration authoring tool for Model-Tracing tutors. *International Journal of Artificial Intelligence in Education, 8*, 233-261.

Blochl, M., Rumetshofer, H., & Wob, W. (2003, September 01 - 05). *Individualized E-Learning Systems Enabled by a Semantically Determined Adaptation of Learning Fragments.* Paper presented at the 14th International Workshop on Database and Expert Systems Applications (DEXA'03), Prague, Czech Republic.

Bloom, B. (1984). The 2 Sigma Problem: The Search for Methods of Group Instruction as Effective as One-to-One Tutoring. *Educational researcher, 13*(6), 4.

Boggs, S., Shore, M., & Shore, J. (2004). Using e-Learning Platforms for Mastery Learning in Developmental Mathematics Courses. *Mathematics and Computer Education, 38*(2), 213.

Bordens, K., & Abbott, B. (2002). *Research design and methods : a process approach* (5th ed.). Boston, Mass. ; London: McGraw Hill.

Broadbent, B. (2000, 05/09/2003). *Championing e-Learning*, from http://www.e-learninghub.com/articles/championing.html

Brooks, D. (1997). *Web-teaching : a guide to designing interactive teaching for the World Wide Web*. New York: Plenum Press.

Brown, J. (2002, December 1-2). *Flexible Rules and Actions For Delivery of Online Courseware Learning Materials.* Paper presented at the Proceedings of the 7th Annual CollECTeR Conference on Electronic Commerce, Melbourne, Victoria.

Brown, J. (2003). *The Case for Conditional Rules and Actions in Learning Management Systems: towards Intelligent Learning Management Systems.* Paper presented at the Proceedings of the International Conference on Internet Computing, IC '03, Las Vegas, Nevada.

Brusilovsky, P. (1994a). The Construction and Application of Student Models in Intelligent Tutoring Systems. *Journal of Computer and Systems Sciences International, 32*(1), 70-89.

Brusilovsky, P. (1994b, 15-19 August). *Student model centered architecture for intelligent learning environments.* Paper presented at the Fourth international conference on User Modeling,, Hyannis, MA, USA.

Brusilovsky, P. (1996). Methods and techniques of adaptive hypermedia. *User Modeling and User - Adapted Interaction, 6*(2/3), 87-129.

Brusilovsky, P. (1999). *Adaptive and Intelligent Technologies for Web-based Education*, 4

Brusilovsky, P. (2000a, June 19-23). *Adaptive Hypermedia: From Intelligent Tutoring Systems to Web-Based Education.* Paper presented at the ITS 2000.

Brusilovsky, P. (2000b, June 19-23). *Course sequencing for static courses? Applying ITS techniques in large scale Web-based education.* Paper presented at the Proceedings of 5th International Conference on Intelligent Tutoring Systems (ITS 2000), Montreal, Canada.

Brusilovsky, P. (2003). Adaptive navigation support in educational hypermedia: The role of student knowledge level and the case for meta-adaptation. *British Journal of Educational Technology, 34*(4), 487-497.

Brusilovsky, P., & Miller, P. (2001). Course delivery systems for the Virtual University. In T. T. T. D. Senta (Ed.), *Access to Knowledge: New Information Technologies and the Emergence of the Virtual University* (pp. 167-206). Amsterdam: Elsevier.

Brusilovsky, P., Schwarz, E., & Weber, G. (1996). ELM-ART: an intelligent tutoring system on thw world wide web. In C. F. A. Lesgold (Ed.), *Intelligent Tutoring Systems* (Vol. 1086, pp. 261-269). Berlin: Spinger Verlag.

Brusilovsky, P., & Vassileva, J. (2003). Course sequencing techniques for large-scale web-based education. *IInternational Journal of Continuing Engineering Education and Lifelong Learning, 13*(1/2), 75-94.

Buchanan, T. (2000). The efficacy of a World-Wide Web mediated formative assessment. *16*(3), 193-193.

Burns, R. (1996). *Introduction to research methods* (3rd ed.). Melbourne: Addison Wesley Longman.

Burt, P. (2004). *Design guidelines for effective e-learning materials*. Retrieved February 18, 2005, from http://www.paulburt.co.uk/e-learning/gu3.htm

Butz, C., Hua, S., & Maguire, R. (2004, September 20 - 24). *A Web-Based Intelligent Tutoring System for Computer Programming.* Paper presented at the Web Intelligence, IEEE/WIC/ACM International Conference on (WI'04).

Byers, C. (2001). Interactive Assessment:an approach to enhance teaching and learning. *Journal of Interactive Learning Research*, 359-374.

Candace, F., De Santo, M., & Vento, M. (2003). *Evaluating On-line Learning Platforms: a Case Study.* Paper presented at the 36th Annual Hawaii International Conference on System Sciences (HICSS'03), Hawaii.

Ceri, S., Dolog, P., Matera, M., & Nejdl, W. (2004). *Model-Driven design of web applications with client-side adaption.* Paper presented at the International Conference on Web Engineering.

Chabonneau, K. (2005). *Jim Berger - What's the Secret to Start Teaching Online?* Retrieved March 18, 2005, from https://www.elearning.ubc.ca/home/index.cfm?menuClicked=11%2F2%2F&p=main/dsp_community_success_jberger.cfm

Chalamish, M., & Kraus, S. (2002). *Learning users interests for providing relevant information.* Paper presented at the ABIS-Workshop 2002: Personalization for the mobile world, Hannover, Germany.

Checkland, P. (1981). *Systems thinking, systems practice*. Chichester Sussex ; New York: J. Wiley.

Checkland, P., & Scholes, J. (1990). *Soft systems methodology in action*. Chichester, West Sussex, England ; New York: Wiley.

Chen, N., Kinshuck, A., Ko, H., & Lin, T. (2004, August 30 - September 01). *Synchronous Learning Model over the Internet.* Paper presented at the IEEE International Conference on Advanced Learning Technologies (ICALT'04), Joensuu, Finland.

Chou, C. (2002). *A comparative content analysis of student interaction in synchronous and asynchronous learning networks.* Paper presented at the Proceedings of the 35th Hawaii international conference onf system sciences.

Chung, C., Shih, T., Huang, J., Wang, Y., & Kuo, T. (1995, May 15-18). *An object-oriented approach and system for intelligent multimedia presentation designs.* Paper presented at the International Conference on Multimedia Computing and Systems (ICMCS'95), Washington, D.C.

Clark, R., & Mayer, R. (2003). *E-Learning and the science of instruction : proven guidelines for consumers and designers of multimedia learning*. San Francisco, CA: Jossey-Bass Publishers.

Clyde, L. (2004). digital learning objects. *Teacher Librarian, 31*(4), 55.

Collins, A., Neville, P., & Bielaczyc, K. (2000). The role of different media in designing learning environments. *International Journal of Artificial Intelligence in Education, 11*, 144-162.

Conati, C., & VanLehn, K. (2001). Providing adaptive support to the understanding of instructional material. In *Proceedings of the 6th international conference on Intelligent user interfaces* (pp. 41-47). Santa Fe, New Mexico, United States: ACM Press.

Corbett, A., & Anderson, J. (2001). Locus of feedback control in computer-based tutoring: impact on learning rate, achievement and attitudes. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 245-252). Seattle, Washington, United States: ACM Press.

Courtney, K., & Patalong, S. (2002). Integrated information skills - a case study using the virtual learning environment WebCT. *Education Libraries Journal, 45*(1), 7.

Craig, S., Gholson, M., Ventura, M., & Graesser, A. (2000). Overhearing dialogues and monologues in virtual tutoring sessions: effecrs on questioning and vicarious learning. *International Journal of Artificial Intelligence in Education, 11*, 242-253.

Darbhamulla, R., & Lawhead, P. (2004a, April). *Curriculum Sequencing using Quizzes and Statistics.* Paper presented at the Proceedings of the Mid-South College Computing Conference (MSCCC), Little Rock, Arkansas.

Darbhamulla, R., & Lawhead, P. (2004b). Paving the way towards an efficient Learning Management System. In *Proceedings of the 42nd annual Southeast regional conference* (pp. 428-433). Huntsville, Alabama: ACM Press.

Dawson, C. (2002). *Practical research methods: a user-friendly guide to mastering research techniques and projects*. Oxford: howtobooks.

DCMI. (2005). *Memorandum of Understanding between the Dublin Core Metadata Initiative and the IEEE Learning Technology Standards Committee*. Retrieved February 23, 2005, from http://dublincore.org/documents/dcmi-ieee-mou/index.shtml

De Bra, P. (2004). *Teaching through Adaptive Hypertext on the Web*. Retrieved May 25, from http://www.win.tue.nl/~debra/ijet/journal.html

De Bra, P., Aerts, A., Smits, D., & Stash, N. (2002). AHA! the next generation. In *Proceedings of the thirteenth ACM conference on Hypertext and hypermedia* (pp. 21-22). College Park, Maryland, USA: ACM Press.

De Bra, P., Brusilovsky, P., & Houben, G. (1999). Adaptive hypermedia: from systems to framework. *ACM Comput. Surv., 31*(4es), 12.

De Bra, P., Houben, G., & Wu, H. (1999). AHAM: a Dexter-based reference model for adaptive hypermedia. In *Proceedings of the tenth ACM Conference on Hypertext and hypermedia : returning to our diverse roots: returning to our diverse roots* (pp. 147-156). Darmstadt, Germany: ACM Press.

Derrick, G., & Pilling-Cormick, J. (2003). *Foundations for Lifelong Learning: Building Successful Self-Directed E-Learning Approaches From K-12 to Higher Education.* Paper presented at the World Conference on E-Learning in Corp., Govt., Health., & Higher Ed. 2003.

Dimitrova, M., Sadler, C., Hatzipanagos, S., & Murphy, A. (2003, September 01-05). *Addressing Learner Diversity by Promoting Flexibility in e-Learning Environments.*

Paper presented at the 14th International Workshop on Database and Expert Systems Applications (DEXA'03), Prague, Czech Republic.

Dodero, J., Fernandez, C., & Sanz, D. (2003). An experience on students' participation in blended vs. online styles of learning. *SIGCSE Bull., 35*(4), 39-42.

Doherty, P. (1998). Learner control in asynchronous learning environments. *ALN Magazine, 2*(2).

Donche, V., Vanhoof, J., & Van Petegem, P. (2003). Beliefs about Learning Environments: How Do Student Teachers Think, Reflect and Act Concerning Self Regulated and Cooperative Learning in Flanders (Belgium)? *Belgium*.

Drew, C., Hardman, M., & Hart, A. (1996). *Designing and conducting research : inquiry in education and social science* (2nd ed.). Boston: Allyn and Bacon.

Dringus, L. (2001). From both sides now: on being an online learner and an online professor. *eLearn, 2001*(5), 2.

Du Boulay, B. (2000). Can We Learn From ITSs? *International Journal of Artificial Intelligence in Education, 11*, 1040-1049.

Du Boulay, B., & Luckin, R. (2001). Modelling human teaching tactics and strategies for tutoring systems. *International Journal of Artificial Intelligence in Education, 12*, 235-256.

Eklund, J. (1995). *Cognitive models for structuring hypermedia and implications for learning from the world-wide web.* Paper presented at the Innovation and Diversity - The World Wide Web in Australia. AusWeb95 - Proceedings of the First Australian World Wide Web Conference, Lismore, NSW.

Eklund, J., & Brusilovsky, P. (1998). The value of adaptivity in hypermedia learning environments: A short review of empirical evidence. In P. B. a. P. D. Bra (Ed.), *Proceedings of Second Adaptive Hypertext and Hypermedia Workshop at the Ninth ACM International Hypertext Conference Hypertext'98* (pp. 13-19). Pittsburgh, PA: Eindhoven University of Technology.

Eklund, J., Garrett, P., Ryan, S., & Harvey, J. (1995). *Designing the world wide web as an educational delivery medium at the University of Sydney.* Paper presented at the ASCILITE95 Conference, Melbourne.

Eklund, J., & Zeiliger, R. (1996). *Navigating the Web: Possibilities and practicalities for adaptive navigational support.* Paper presented at the of Ausweb96: The Second Australian World-Wide Web Conference.

elearnspace. (2002). *Preparing students for Elearning*. Retrieved February 10, 2005, from http://www.elearnspace.org/Articles/Preparingstudents.htm

Eom, W., & Reiser, R. (2000). The effects of self-regulation and instructional control on performance and motivation in computer-based instruction. *International Journal of Instructional Media, 27*(3), 247-260.

Farrell, R., Liburd, S., & Thomas, J. (2004). Dynamic assembly of learning objects. In *Proceedings of the 13th international World Wide Web conference on Alternate track papers \& posters* (pp. 162-169). New York, NY, USA: ACM Press.

Fernandez, G. (2001). WebLearn: a Common Gateway Interface (CGI)-Based environment for interactive learning. *Journal of Interactive Learning Research, 12*(2/3), 265-280.

Fischer, S. (2001). Course and exercise sequencing using metadata in adaptive hypermedia learning systems. *J. Educ. Resour. Comput., 1*(1es), 5.

Friedland, G., & Pauls, K. (2005). Architecting multimedia environments for teaching. *Computer, 38*(6), 57-63.

Gabrys, G., Weiner, A., & Lesgold, A. (1993). Learning by problem solving in a coached apprenticeship system. In M. Rabinowitz (Ed.), *Cognitive science foundations of instruction* (pp. 119-147). New Jersey: Erlbaum.

Gagne, D., & Trudel, A. (1996). *A Highly flexible student driven architecture for computer based instruction.* Paper presented at the Intelligent Tutoring Systems: Third International Conference ITS '96.

Galliers, R., & Land, F. (1987). Viewpoint: choosing appropriate information systems research methodologies. *Commun. ACM, 30*(11), 901-902.

Garrison, D., & Anderson, T. (2003). *E-learning in the 21st century : a framework for research and practice*. London ; New York: RoutledgeFalmer.

Gauss, B., & Urbas, L. (2003). Individual difference in navigation between sharable content objects - an evaluation study of a learning module prototype. *British Journal of Educational Technology, 34*(4), 499-509.

Gerhard, J., & Mayr, P. (2002). *Competing in the E-learning environment - strategies for universities.* Paper presented at the 35th Annual Hawaii International Conference on System Sciences (HICSS'02).

Glenn, L., Jones, C., & Hoyt, J. (2003). The effect of interaction levels on student performance: a comparative analysis of web mediated versus traditional delivery. *Journal of Interactive Learning Research, 14*(3), 285-299.

Gronbaek, K., & Trigg, R. (1996). Toward a Dexter-based model for open hypermedia: unifying embedded references and link objects. In *Proceedings of the the seventh ACM conference on Hypertext* (pp. 149-160). Bethesda, Maryland, United States: ACM Press.

Grutzner, I., Angkasaputra, N., & Pfahl, D. (2002). A systematic approach to produce small courseware modules for combined learning and knowledge management environments. In *Proceedings of the 14th international conference on Software engineering and knowledge engineering* (pp. 533-539). Ischia, Italy: ACM Press.

Halasz, F., & Schwartz, M. (1994). The Dexter hypertext reference model. *Commun. ACM, 37*(2), 30-39.

Hannafin, M. (1984). Guidelines for Using Locus of Instructional Control in the Design of Computer-Assisted Instruction. *Journal of instructional development, 7*(3), 6.

Hanscom, M. (2003). *Print-friendly pages with CSS*. Retrieved March 10, 2005, from http://www.michaelhanscom.com/eclecticism/2003/09/print-friendly.html

Hansen, S., Salter, G., Simpson, K., & Davies, P. (1999). *Online Assessment with Large Classes:-Issues, Methodologies and Case Studies.* Paper presented at the World Conference on the WWW and Internet 1999.

Hayashi, A., Chen, C., Ryan, T., & Wu, J. (2004). The role of social presence and moderating role of computer self efficacy in predicting the continuance usage of e-learning systems. *Journal of Information Systems Education, 15*(2), 139-154.

Heift, T., & Nicholson, D. (2001). Web delivery of adaptive and interactive language tutoring. *International Journal of Artificial Intelligence in Education, 12*(4), 310-325.

Helic, D., Maurer, H., & Scerbakov, S. (2004). Combining individual tutoring with automatic course sequencing in WBT systems. In *Proceedings of the 13th international World Wide Web conference on Alternate track papers \& posters* (pp. 456-457). New York, NY, USA: ACM Press.

Henze, N., & Nejdl, W. (2001). Adaption in open corpus hypermedia. *International Journal of Artificial Intelligence in Education Special Issue on Adaptive*

and Intelligent Web-Based Systems, 12.

Hirumi, A. (2002). The Design and Sequencing of eLearning Interactions:A Grounded Approach. *International Journal on E-Learning, 1*(1), 19-27.

Horton, W. (2000). *Designing Web-Based Training*. New York: Wiley.

Horton, W. (2002). *Using E-Learning*. Virginia: American Society for Training and Development.

Iahad, N., Dafoulas, G., Kalaitzakis, E., & Macaulay, L. (2004). *Evaluation of Online Assessment: The Role of Feedback in Learner-Centered e-Learning*. Paper presented at the Proceedings of the 37th Annual Hawaii International Conference on System Sciences (HICSS'04), Hawaii.

Ignizio, J. (1991). *Introduction to expert systems: the development and implementation of rule-based expert systems* (International Edition ed.). New York: McGaw-Hill.

IMS. (2003a). *IMS Simple Sequencing best pratice and implementation guide*. Retrieved march 5, 2005, from http://www.imsglobal.org/simplesequencing/ssv1p0/imsss_bestv1p0.html

IMS. (2003b). *IMS Simple Sequencing Information and Behavior Model*. Retrieved March 5, 2005, from http://www.imsglobal.org/simplesequencing/ssv1p0/imsss_infov1p0.html

IMS. (2005). *IMS Simple Sequencing Specification*. Retrieved March 5, 2005, from http://www.imsglobal.org/simplesequencing/

ION. (2005). *Weaknesses of Online Learning*. Retrieved July 7, 2005, from http://www.ion.uillinois.edu/resources/tutorials/overview/weaknesses.asp

Jegan, T., & Eswaran, C. (2004). patterns for E-Learning content development. *Journal of Interactive Learning Research, 15*(2), 117-113.

Jicks, T. (1979). Mixing qualitative and quantitative methods: triangulation in action. *Adinistrative Science Quarterly, 24*(12), 602-611.

Johnson, A., & Ruppert, S. (2002). An evaluation of accessibility in online learning management systems. *Library Hi Tech, 20*(4), 441.

Karagiannidis, C., Sampson, D., & Cardinali, F. (2001). Integrating Adaptive Educational Content into Different Courses and Curricula. *Educational Technology & Society, 4*(3), 37.

Karampiperis, P., & Sampson, D. (2005). Designing learning services: from content-based to activity-based learning systems. In *Special interest tracks and posters of the 14th international conference on World Wide Web* (pp. 1110-1111). Chiba, Japan: ACM Press.

Katz, S., Lesgold, A., Eggan, G., & Gordin, M. (1993). Modeling the student in Sherlock II. *Journal of Artificial Intelligence in Education*, 495-518.

Khan, B. (2001). *Web-based training*. Englewood Cliffs, NJ: Educational Technology Publications.

Kohavi, R. (2001). Mining e-commerce data: the good, the bad, and the ugly. In *Proceedings of the seventh ACM SIGKDD international conference on Knowledge discovery and data mining* (pp. 8-13). San Francisco, California: ACM Press.

Leung, K. (2002). *Diagnostic Cognitive Assessment and E-learning.* Paper presented at the World Conference on E-Learning in Corp., Govt., Health., & Higher Ed. 2002.

Ley, K., & Young, D. (2001). Instructional principles for self-regulation. *Educational Technology Research and Development, 49*(2), 930103.

Li, Q., & Lochovsky, F. (1998). ADOME: an advanced object oriented modeling environment. *IEEE transactions of knowledge and data engineering, 10*(2), 255-276.

Li, X., & Soh, L. (2004). *A literature review on learner control strategies in software tutoring systems* (Technical Report). Lincoln: University of Nebraska-Lincoln.

Lindvall, M., Rus, I., & Sinha, S. (2003). Software systems support for knowledge management. *Journal of Knowledge Management, 7*(5), 137.

Liu, Y., Lin, F., & Wang, X. (2003). Education practice and analysing behaviour of students in a web-based learning environment: an exploratory case study. *Online Information Review, 27*(2), 110-119.

LSAL, L. S. A. L. (2005). *Just Simple Sequencing*, from http://www.lsal.cmu.edu/lsal/resources/standards/ss/

Lundquist, R. (2001). *Quiz collaboration –- cheating or a learning opportunity?* Paper presented at the World Conference on Educational Multimedia, Hypermedia and Telecommunications 2001.

Lytras, M. (2002). *E-learning pedagogy: The reveal of value adding learning processes. Definitions and Implications for dynamic learning content delivery.* Paper presented at the World Conference on E-Learning in Corp., Govt., Health., & Higher Ed. 2002.

Lytras, M., Pouloudi, A., & Poulymenakou, A. (2002). Knowledge management convergence - expanding learning frontiers. *Journal of Knowledge Management, 6*(1), 40.

Mazza, R., & Dimitrova, V. (2004). Visualising student tracking data to support instructors in web-based distance education. In *Proceedings of the 13th international World Wide Web conference on Alternate track papers \& posters* (pp. 154-161). New York, NY, USA: ACM Press.

McCray, G. (2000). The hybrid course: merging on-line instruction and the traditional classroom. *Information Technology and Management, 1*(4), 307.

McGrath, D. (1992). Hypertext, CAI, Paper, or Program Control: Do Learners Benefit from Choices? *Journal of research on computing in education, 24*(4), 513.

Melis, E., Andres, E., Budendender, J., Frischauf, A., Goguadze, G., Libbrecht, P., et al. (2001). ActiveMath: a generic and adaptive web-based learning environment. *International Journal of Artificial Intelligence in Education, 12*, 385-407.

Miskelly, T. (1998). Interactive student modeling. In *Proceedings of the 36th annual Southeast regional conference* (pp. 88-94): ACM Press.

Mohan, P., Greer, J., & McCalla, G. (2003). *Instructional Planning with Learning Objects.* Paper presented at the IJCAI 2003 Workshop on Knowledge Representation and Automated Reasoning for E-Learning Systems, Acapulco, Mexico.

Montgomery, A., Li, S., Srinivasan, K., & Liechty, J. (2004). Modeling Online Browsing and Path Analysis Using Clickstream Data. *Marketing science, 23*(4), 579.

Morss, D. (1999). A study of student perspectives on Web-based learning: WebCT in the classroom. *Internet Research, 9*(5), 393.

MTS. (2003). *e-learning FAQs*. Retrieved 25/02/2005, 2005, from http://www.ministrytrainingsource.org/elearning.htm

Murray, T. (1999). Authoring intelligent tutoring systems: an analysis of the state of the art. *International Journal of Artificial Intelligence in Education, 10*, 98-129.

Murugaiah, P., Atan, H., Samsudin, D., & Idrus, R. (2004). *The Web-Based Learning Environment: A Comparative Study between the Constructivist and Content-Based Approaches.* Paper presented at the IEEE International Conference on Advanced Learning Technologies (ICALT'04), Joensuu, Finland.

Neville, V., & Bennett, S. (2004, December 5-8). *Using self regulated learning to manage the discomfort of becoming fluent with information technology.* Paper presented at the Beyond the comfort zone: Proceedings of the 21st ASCILITE Conference, Perth.

Nichani, M. (2001). *LCMS = LMS + CMS [RLOs]*. Retrieved 19/02/2005, 2005, from http://www.elearningpost.com/features/archives/001022.asp

Nunamaker, J., Chen, M., & Purdin, T. (1991). Systems development in information systems research. *Journal of Management Information Systems, 7*(13), 89-106.

Olfman, L. (1984). Research issues in systems development prototyping. *SIGCPR Comput. Pers., 9*(4), 6-16.

Ong, J., & Ramachandran, S. (2000). *Intelligent Tutoring Systems: The What and the How*, from http://www.learningcircuits.org/2000/feb2000/ong.htm

Padmanabhan, B., Zheng, Z., & Kimbrough, S. (2001). Personalization from incomplete data: what you don't know can hurt. In *Proceedings of the seventh ACM SIGKDD international conference on Knowledge discovery and data mining* (pp. 154-163). San Francisco, California: ACM Press.

Papanikolaou, K., Grigoriadou, M., Kornilakis, H., & Magoulas, G. (2003). Personalizing the Interaction in a Web-based Educational Hypermedia System: the case of INSPIRE. *User Modeling and User - Adapted Interaction, 13*(3), 213.

Paris, P. (2004). E-Learning: a study on secondary students' attitudes towards online wev assisted learning. *International Education Journal, 15*(1), 98-112.

Parker, M. (2003). Technology-enhanced e-Learning: perceptions of first year information systems students at the Cape Technikon. In *Proceedings of the 2003 annual research conference of the South African institute of computer scientists and information technologists on Enablement through technology* (pp. 316-319): South African Institute for Computer Scientists and Information Technologists.

Parrish, P. (2004). The Trouble with Learning Objects*. *Educational Technology, Research and Development, 52*(1), 49.

Patalong, S. (2003). Using the virtual learning environment WebCT to enhance information skills teaching at Coventry University. *Library Review, 52*(3/4), 103.

Pathak, S., & Brusilovsky, P. (2002, June 24-29). *Assessing Student Programming Knowledge with Web-based Dynamic Parameterized Quizzes.* Paper presented at the ED-MEDIA'2002 - World conference on Educational Multimedia, Hypermedia and Telecommunications, Denver, Colorado.

Paulsen, M. (2002). Online education systems in Scandinavian and Australian universities: a comparative study. *International Review of Research in Open and Distance Learning*.

Paulsen, M. (2003). *Online Education and Learning Management Systems: Global E-learning in a Scandinavian Perspective*. Retrieved 20/03/2005, 2005, from http://www.studymentor.com/studymentor/

Perez, Y., Gamboa, R., & Ibarra, O. (2004, August 30 - September 01). *Modeling Affective Responses in Intelligent Tutoring Systems.* Paper presented at the IEEE International Conference on Advanced Learning Technologies (ICALT'04), Joensuu, Finland \.

Poling, A., & Fuqua, R. (1986). *Research methods in applied behavior analysis : issues and advances*. New York: Plenum Press.

Pope, C. (Ed.). (2001). *In Action : Implementing E-Learning Solutions*. Alexandria: Amer Society Training & Development.

Presby, L. (2001, June). Seven Tips for Highly Effective Online Courses. *Syllabus Magazine,* 17.

Psaromiligkos, Y., & Retalis, S. (2003). Re-evaluating the effectiveness of a web-based learning system: a comparative case study. *Journal of Educational Multimedia and Hypermedia, 12*(1), 5-20.

Richardson, R. (2003). Approaches to studying and perceptions of academic quality in a short web-based course. *British Journal of Educational Technology, 34*(4), 433-442.

Ring, J. (1998). *Navigational styles in hypermedia information systems and the relationship between their effectiveness and cognitive style, age, gender, prior experience and perceptions.* Unpublished PhD, University of Western Australia, Perth.

Rugg, W. (2003). Technology review: A primer on course management systems. *The Community College Enterprise, 9*(1), 95.

Rumbaugh, J., Blaha, M., Premerlani, W., Eddy, F., & Lorensen, W. (1991). *Object-oriented modelling and design* (International Edition ed.). New York: Prentice Hall.

Sadler, C., Bakry, W., Chera, P., Hatzipanagos, S., Milankovic-Atkinson, M., & Murphy, A. (2002, September 02 - 06,). *Global Campus: Learning to Walk with Webbed Feet.* Paper presented at the 13th International Workshop on Database and Expert Systems Applications (DEXA'02).

Sandercock, G., & Shaw, G. (1999). Learners' performance and evaluation of attitudes towards web course tools in the delivery of an applied sports science module. *ALN Magazine, 3*(2), 1-8.

Schank, R. (2002). *Designing World Class E-Learning*: McGraw-Hill.

Schwabe, D., & Rossi, G. (1998). An Object Oriented Approach to Web-Based Application Design, *Theory and Practice of Object Systems* (Vol. 4). New York: Wiley and Sons.

Schwabe, D., Rossi, G., Esmeraldo, L., & Lynardet, F. (2001). Engineering web applications for reuse. *IEEE Multimedia*, 2-12.

Shang, Y., Shi, H., & Chen, S. (2001). An intelligent distributed environment for active learning. *Journal on Educational Resources in Computing, 1*(2es), 4.

Shepherd, C. (2003). *Is the world ready for self-study?* Retrieved October 9, 2004, from http://www.trainingfoundation.com/articles/default.asp?PageID=1535

Sison, R., & Shimura, M. (1998). Student modeling and machine learning. *International Journal of Artificial Intelligence in Education, 9*, 128-158.

Spencer, D., & Hiltz, S. (2001, January 03-06). *Studies of ALN: An Empirical Assessment.* Paper presented at the 34th Annual Hawaii International Conference on System Sciences (HICSS-34), Hawaii.

Swan, K., Shea, P., Fredericksen, E., Pickett, A., & Maher, G. (2000). *Course Design Factors Influencing the Success of Online Learning.* Paper presented at the World Conference on the WWW and Internet 2000.

Tang, T., & McCalla, G. (2003). *Towards Pedagogy-Oriented Paper Recommendations and Adaptive Annotations for a Web-Based Learning System.* Paper presented at the

EIGHTEENTH INTERNATIONAL JOINT CONFERENCE ON ARTIFICIAL INTELLIGENCE.

Tennyson, R., Park, O., & Christensen, D. (1985). Adaptive Control of Learning Time and Content Sequence in Concept Learning Using Computer-Based Instruction. *Journal of Educational Psychology, 77*(4), 481-491.

Thoennessen, M., Kashy, E., Tsai, Y., & Davis, E. (1999). Impact of asynchronous learning networks in large lecture classes. *Group decision and negotiation, 8*(5), 371-384.

Thomson. (2005). *Assessments Now*. Retrieved 17/02/2005, 2005, from http://www.netg.com/content/enrichments/assessmentsnow.asp

Triantafillou, E., Pomportsis, A., & Demetriadis, S. (2003). The design and the formative evaluation of an adaptive educational system based on cognitive styles. *Computers & Education, 41*, 87-103.

Tucker, S., Pigou, A., & Zaugg, T. (2002). e-Learning: making it happen now. In *Proceedings of the 30th annual ACM SIGUCCS conference on User services* (pp. 292-293). Providence, Rhode Island, USA: ACM Press.

Udell, J. (2004). The Artful Logger. *InfoWorld, 26*(21), 44.

Unfred, D., & Crooks, S. (2001). *Learner Self-efficacy, Attitude, and Utilization Patterns for an Electronic Textbook.* Paper presented at the Society for Information Technology and Teacher Education International Conference 2001.

UWA. (2003). *Towards a Definition of Online Learning at UWA*. Retrieved 20/03/2005, 2005, from http://www.catl.uwa.edu.au/online/definition

VanLehn, K. (1997). Evaluation of an assessment system based on Bayesian student modeling. *International Journal of Artificial Intelligence in Education, 8*, 179-221.

Virvou, M., & Moundridou, M. (2001). Adding an instructor modelling component to the architecture of ITS authoring tools. *International Journal of Artificial Intelligence in Education, 12*, 185-211.

Vrasidas, C. (2004). Issues of pedagogy and design in e-learning systems. In *Proceedings of the 2004 ACM symposium on Applied computing* (pp. 911-915). Nicosia, Cyprus: ACM Press.

Walker, R., & Jeurissen, R. (2003). E-Based Solutions to Support Intercultural Business Ethics Instruction: An Exploratory Approach in Course Design and Delivery. *Journal of Business Ethics, 48*(1), 113.

Weber, G., & Brusilovsky, P. (2001). ELM-ART: an adaptive versatile system for web-based instruction. *International Journal of Artificial Intelligence in Education, 12*, 351-384.

Wescourt, K., Beard, M., & Gould, L. (1977). Knowledge-based adaptive curriculum sequencing for CAI: Application of a network representation. In *Proceedings of the 1977 annual conference* (pp. 234-240): ACM Press.

Whitehurst, R., Powell, C., & Izatt, L. (1998). Utilising the student model in distance learning. In *Proceedings of the 6th annual conference on the teaching of computing and* *the 3rd annual conference on Integrating technology into computer science education: Changing the delivery of computer science education* (pp. 254-256). Dublin City Univ., Ireland: ACM Press.

Williamson, K. (2002). *Research methods for students, academics and professionals : information management and systems* (2nd ed.). Wagga Wagga, N.S.W.: Centre for Information Studies Charles Sturt University.

Winslow, J. (2001). *Got Hack? Strategies to Reduce Online Cheating.* Paper presented at the Society for Information Technology and Teacher Education International Conference 2001.

Wu, H. (2000). *Supporting user adaption in adaptive hypermedia applications.* Paper presented at the On-line Conference and Informatiewetenschap 2000, Rotterdam, the Netherlands.

Wu, H., & De Bra, P. (2001). Sufficient Conditions for Well-Behaved Adaptive Hypermedia Systems. In *Proceedings of the First Asia-Pacific Conference on Web Intelligence: Research and Development* (pp. 148-152): Springer-Verlag.

Yang, J., Chiu, C., Tsai, C., & Wu, T. (2004, August 30 - September 01). *Visualized Online Simple Sequencing Authoring Tool for SCORM-Compliant Content Package.* Paper presented at the IEEE International Conference on Advanced Learning Technologies (ICALT'04), Joensuu, Finland.

Young, D., & Ley, K. (2003). Self-regulation support offered by developmental educators. *Journal of Developmental Education, 27*(2), 2.

Young, D., & Ley, K. (2004). Effectiveness of POME Instructional Model. *Research & Teaching in Developmental Education, 21*(1), 5.

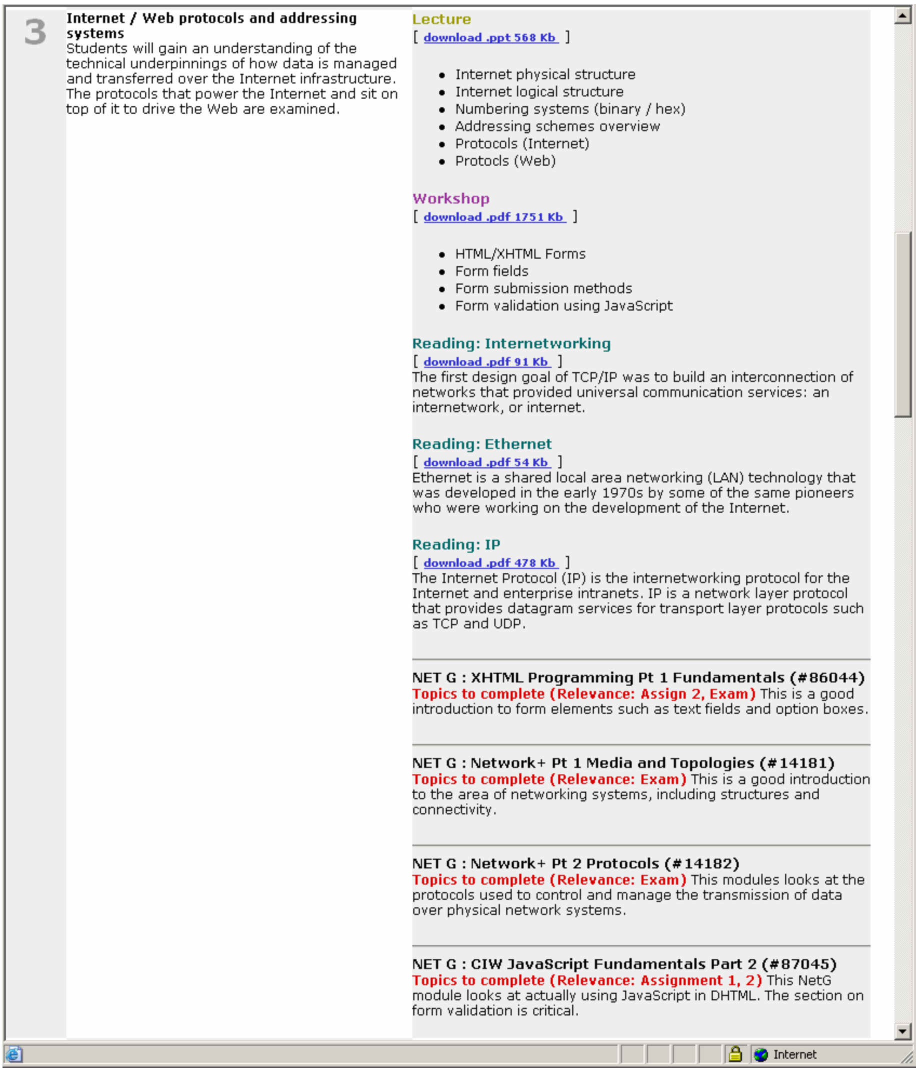
Young, J. (1996). The effect of self-regulated learning strategies on performance in learner controlled computer-based instruction. *Educational Technology Research and Development, 44*(2), 17-27.

Zimmerman, B., & Martinez-Pons, M. (1990). Student Differences in Self-Regulated Learning: Relating Grade, Sex, and Giftedness to Self-Efficacy and Strategy Use. *Journal of educational psychology, 82*(1), 51.

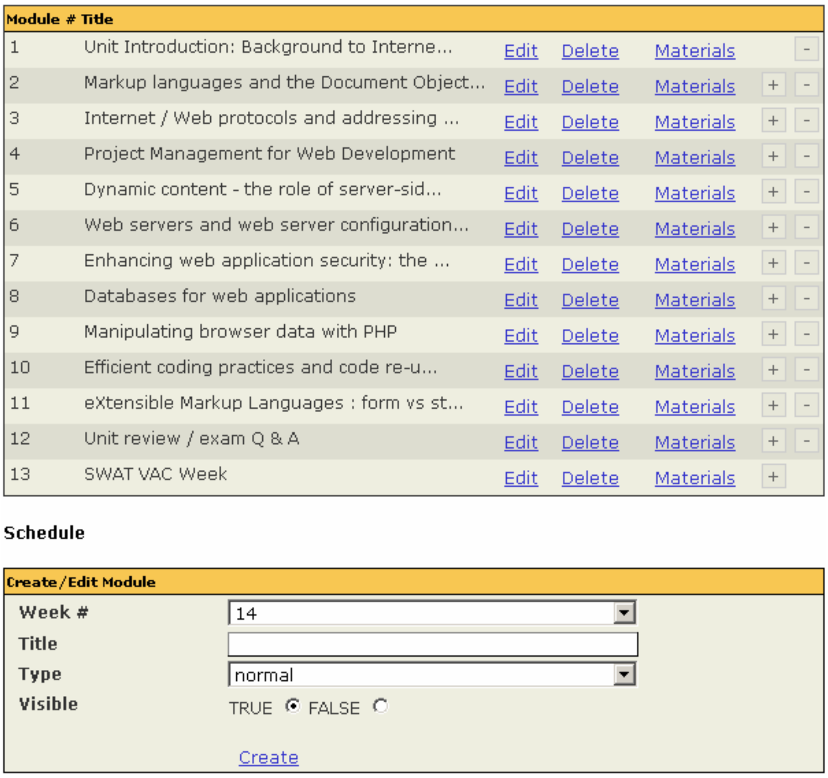
Appendix A - Systems

existing Learning Content Management System (eLCMS)

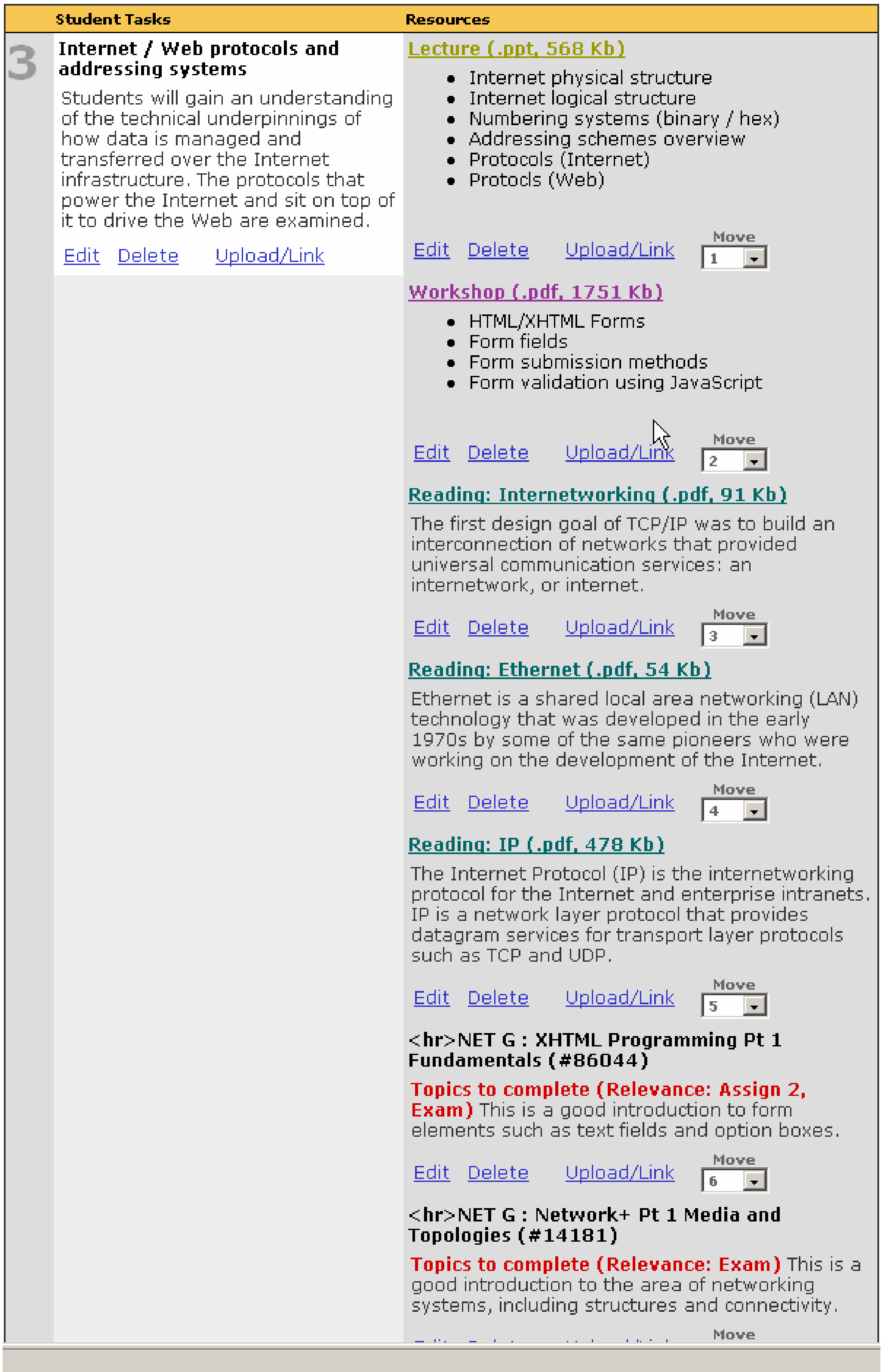
Student view of week three materials in eLCMS



Staff view of eLCMS semester schedule

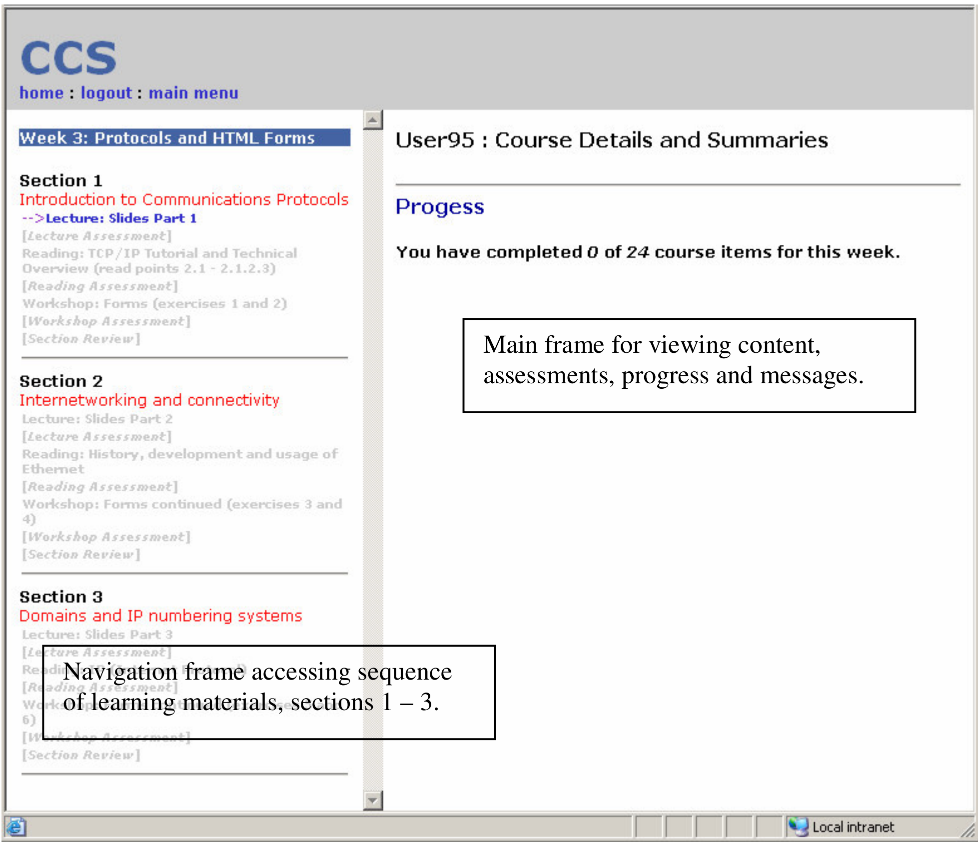


Staff view of week three materials within eLCMS schedule.

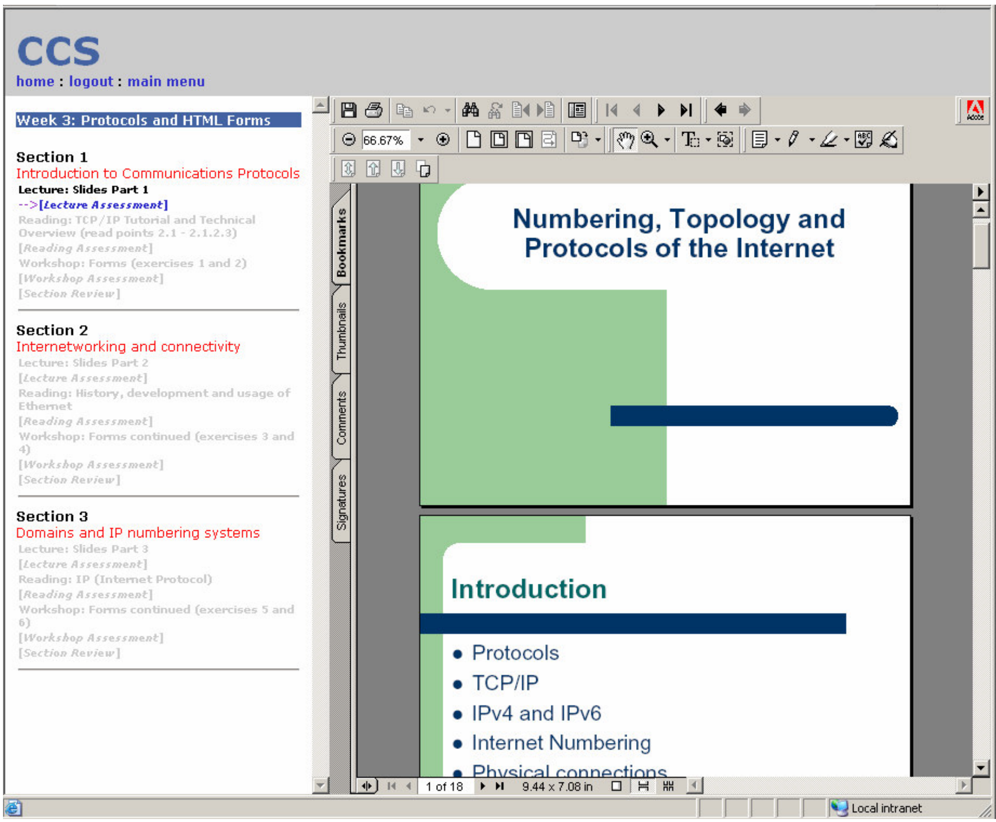


CCS System

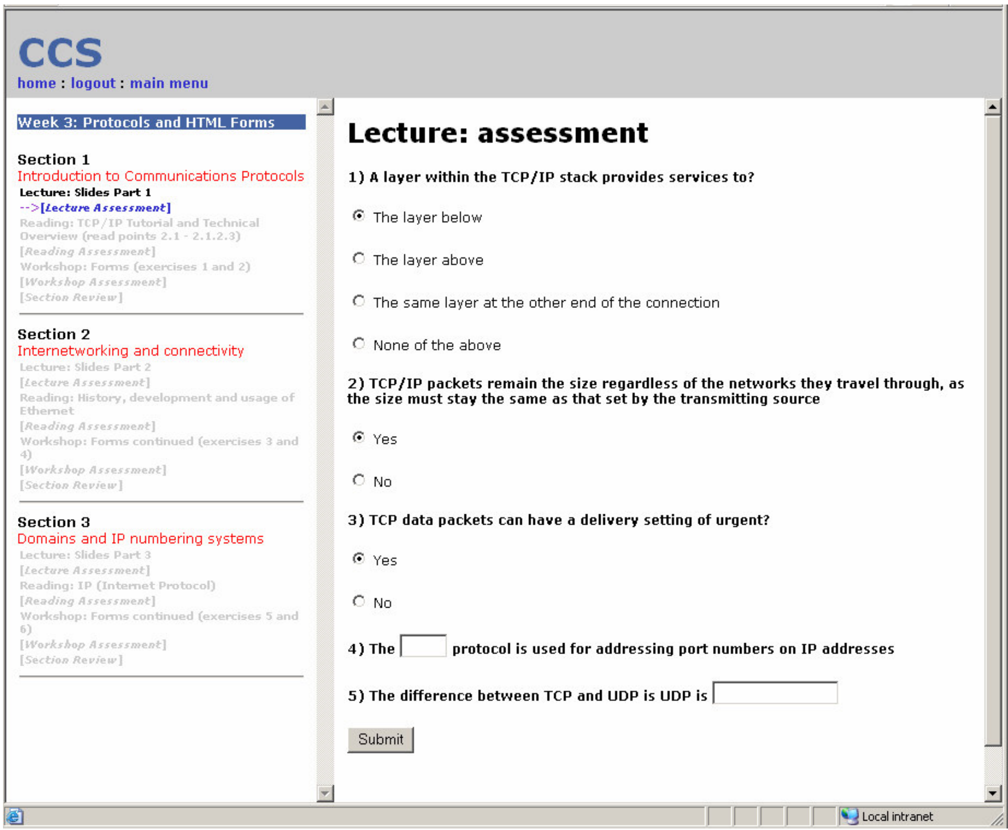
Student view of CCS system during initial login



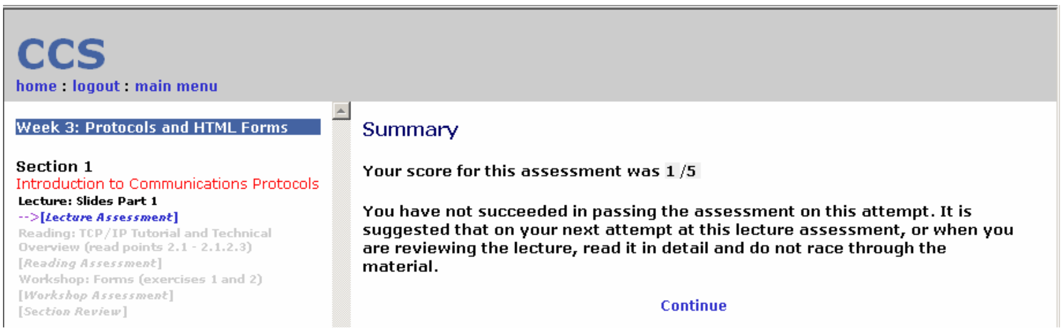
Lecture slides part 1 clicked



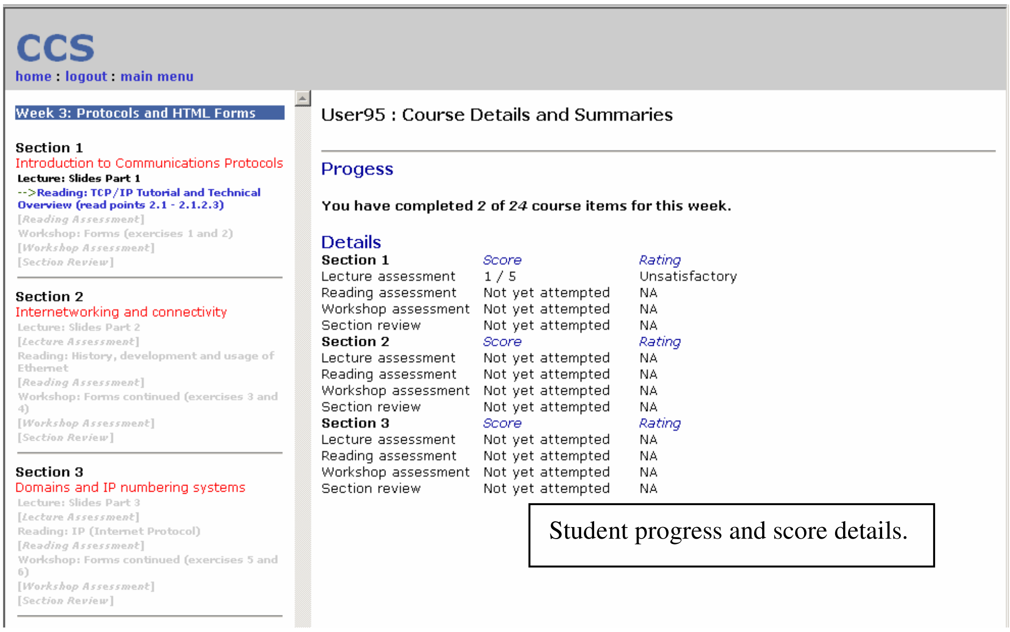
Lecture slides part 1 assessment clicked



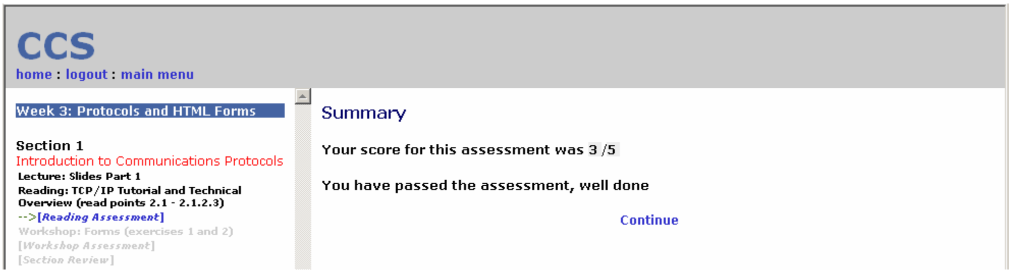
Assessment review and hint



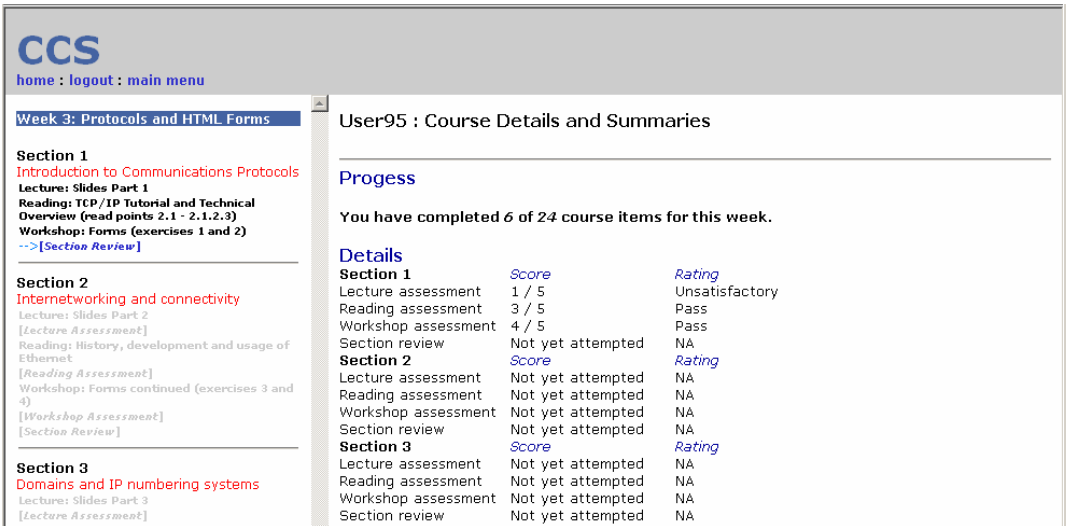
Section one lecture slides and assessment completed



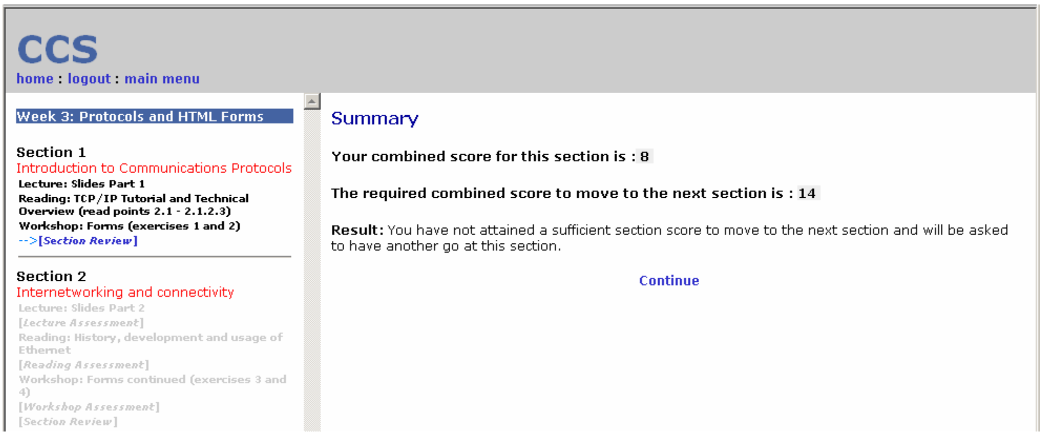
Section one reading, message for passing the assessment



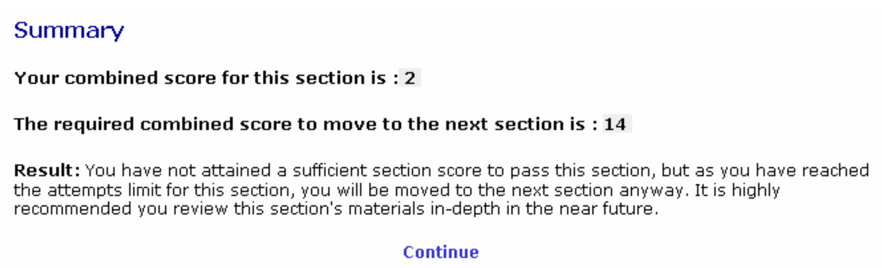
Learning content items for section one complete with section review pending



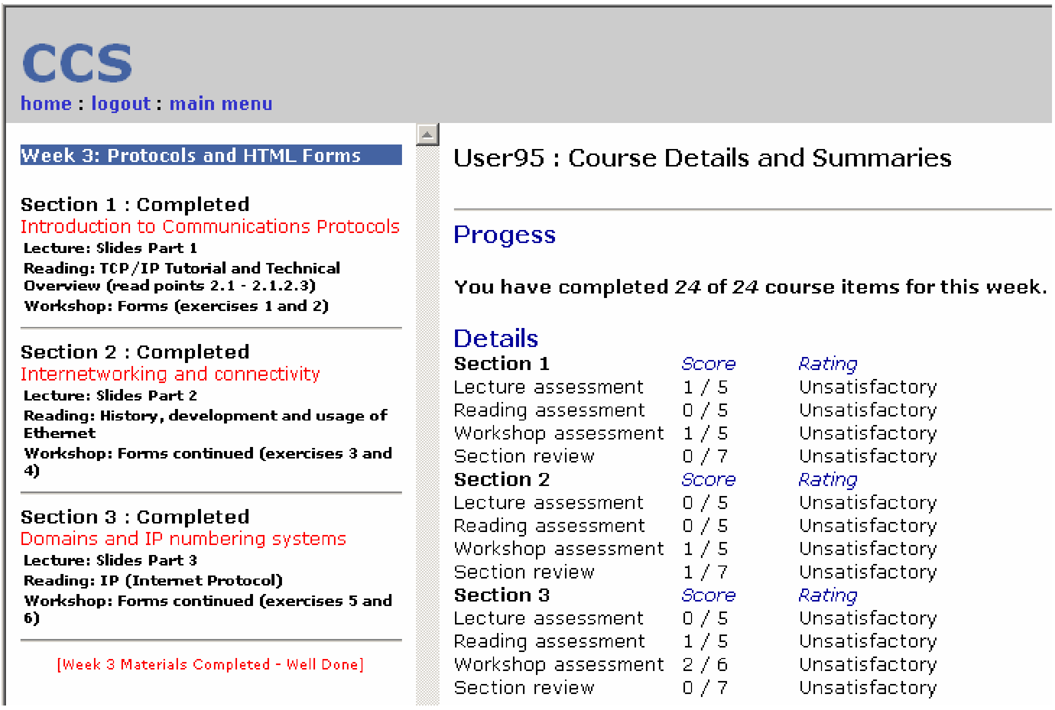
Message to participants indicating section to be repeated



Message presented on unsuccessful second attempt at section



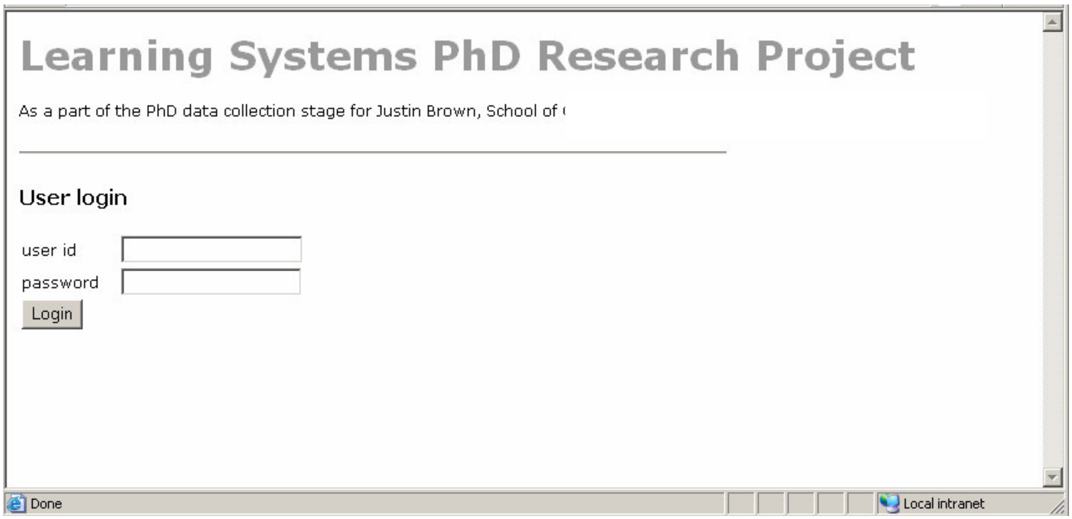
All CCS content completed (default settings)



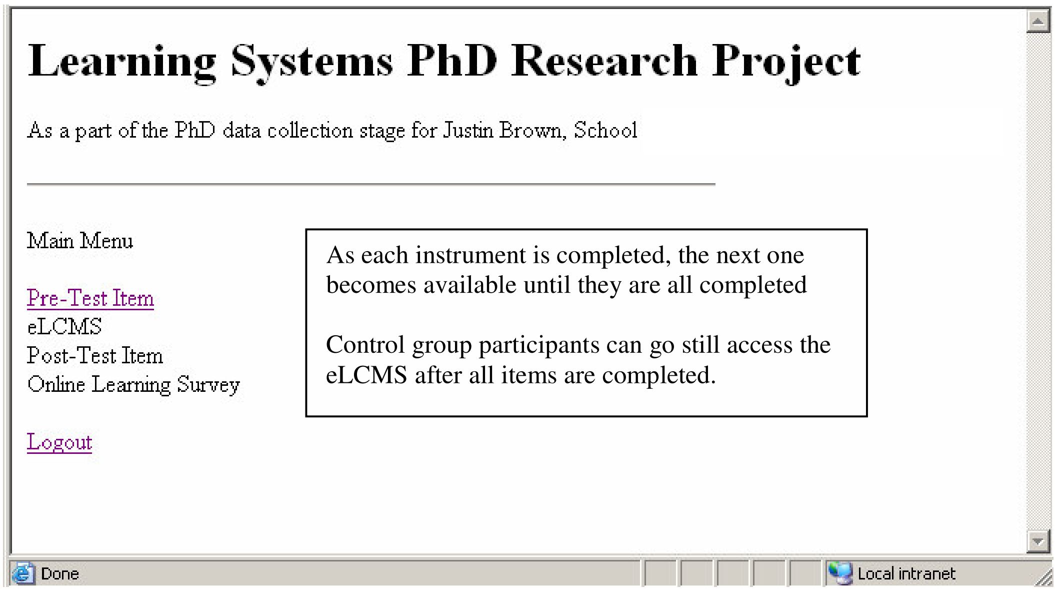
Integrated Account System

The Integrated Account System refers to the account system used by participants in the control and treatment group in order to access the various data collection instruments within the study.

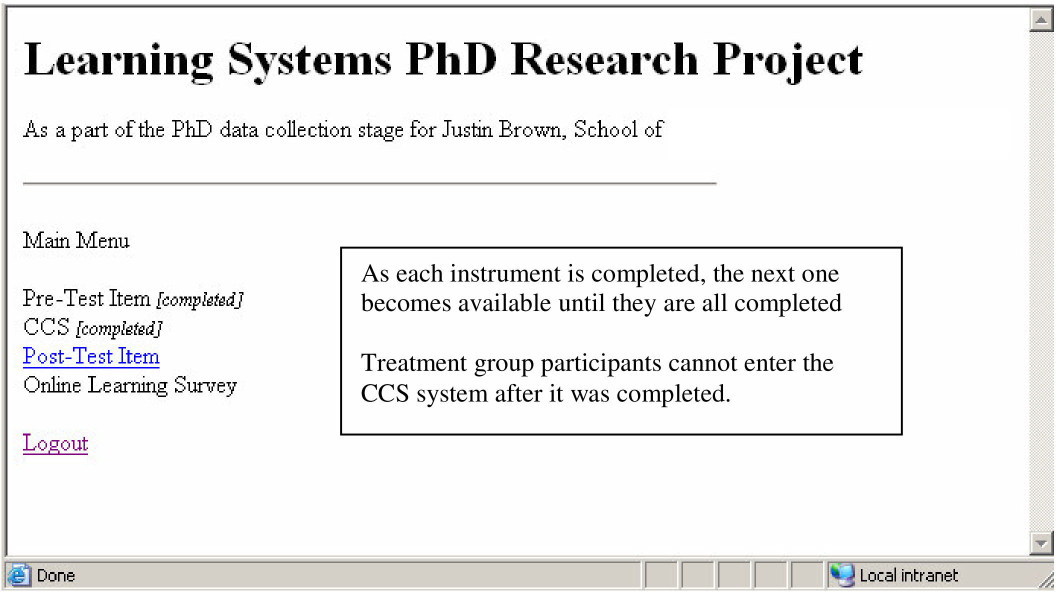
Central login screen for Integrated Account System



Control group participant version of Integrated Account System



Treatment group participant version of Integrated Account System



Appendix B - Instruments

Pre-Test Instrument

Week 3 Materials Pre-Test

As a part of the PhD data collection stage for Justin Brown, School of ......

Before entering the Week 3 materials in your web programming unit, I would ask you to fill in a small multiple-choice test that covers the main topics examined in the lectures, readings and workshops. This test simply gives me an idea of the pre-existing knowledge each student has on the topics covered in week 3. By establishing a baseline for the students involved in my study I can see what the general level of knowledge is for each group of students before and after using the respective materials delivery methods.

As stated previously, the results of these tests will in no way affect your scores or evaluations within this unit or your course as a whole. Also, you will not be given the answers, as I will be asking you to sit the same test again after you have completed your study materials for the week As this first test is looking to establish what you know now, please do not spend too much time deliberating on individual questions or researching them externally. Simply answer the questions you know, and take a best guess on those you are not so sure about.

Many thanks, Justin

1. Which of the following is a form submission method?

- ○ Get
- ○ Action
- ○ EncrypType
- ○ OnSubmit

2. On what port does HTTP transmit data over TCP/IP

- ○ 25
- ○ 80
- ○ 110
- ○ 143

3. A device that allows IP traffic to move between networks of different domain numbering is a

- ○ Gateway
- ○ Bridge
- ○ Hub
- ○ Router

4. To set the maximum amount of information that can be entered into text field you would use?

- ○ MaxSize
- ○ MaximumLen
- ○ MaxLength
- ○ A maximum length cannot be set using html

5. TCP operates on what layer of the internet model:

- ○ Internetwork
- ○ Network Interface and Network
- ○ Transport
- ○ Application

6. Which of the following protocols is most suited to stream meading applications over the WWW?

- TCP
- RDP
- FTP
- UDP
- None of the above

7. Internet Protocol version 6 (IPv6) has a binary number range of?

- 32 bits
- 64 bits
- 128 bits
- 192 bits

8. A form checkbox can be used to send multiple values against a single field name:

- True
- False

9. The order in which the JavaScript function checks the field values must be the same order in which those fields appear in the form:

- True
- False

10. When a html form is submitted, the data in the form is sent to a location specified by the form:

- Element
- Target
- Property
- Action
- None of the above

11. A Class A web address can allow how many hosts:

- 254
- 65 534
- 16 777 214
- None of the above

12. JavaScript form validation prevents any errors getting to the server-side scripting system:

- True
- False

13. Email services would be dealt with at which level of the OSI model:

- Physical
- Data Link
- Application
- Presentation
- Network
- Session
- Transport

14. T1 connections run at what bandwidth:

- ○ 256Kbps
- ○ 512Kbps
- ○ 1.54Mbps
- ○ 20Mbps

15. Which of the following is most often used for client-side form validation:

- ○ JavaScript
- ○ VBscript
- ○ PHP
- ○ None of the above

16. A contentionless link is defined as:

- ○ A period of extremely low network traffic when no packet collision takes place
- ○ A direct cable connection between two network devices
- ○ A direct, virtual connection between two devices over the network
- ○ None of the above

17. It is only possible to change the background colour of a textfield using CSS:

- ○ True
- ○ False

18. The order in which the JavaScript function checks the field values must be the same order in which those fields appear in the form:

- ○ True
- ○ False

19. TCP/IP packets remain the size regardless of the networks they travel through, as the size must stay the same as that set by the transmitting source:

- ○ True
- ○ False

20. TCP/IP is a common method of referring to two different protocols that do very different jobs:

- ○ True
- ○ False

21. What Class of IP address would normally be used with a home network:

- ○ A
- ○ B
- ○ C
- ○ Private networks do not usually fall within recognised IP address classes

22. For web applications requiring accuracy of data delivery, the required protocol would be:

- ○ FTP
- ○ ARP
- ○ UDP
- ○ None of the above

23. An octect in network addressing refers to:

- 1 byte of information
- 64 bits of information
- An address range measured from 0 to 255
- None of the above

24. Routers are effectively invisible to the Internet Protocol, and intercept IP traffic rather than have IP traffic aimed at them:

- True
- False

25. The difference between using the *localhost* address and a *fully qualified* web address (url) is:

- Localhost means the system will find the local address automatically without having to know it
- Localhost will only run on the local machine, excluding outside connections
- A web server can only operate in either localhost mode or fully qualified (external access) mode, not both at one
- Localhost is just a pseudonym for 127.0.0.1

26. Some methods used to conserve IP address usage include:

- Internal domain servers and private IP ranges
- Intranets communicating with the open Internet using Network Address Translarion
- Both of the above
- Neither of the above

27. The technique used to process submitted form data on the server-side is referred to as:

- CGI
- FastCGI
- Both of the above
- Neither of the above

28. MTU is an acronym for:

- Minimum Transferrable Unit
- Maximum Transferrable Unit
- Mean Time Until
- Mean Total Upload

29. 127.0.0.0 is an example of what type of IP address class:

- unallocated
- Broadcast
- Multicast
- Loopback
- Is not considered a member of a TCP/IP stack class

30. Within the confines of the Document Object Model, html forms cannot be changed dynamically with JavaScript:

- True
- False
- They can, but only using Internet Explorer
- None of the above

Post-Test Instrument

Week 3 Materials Post-Test

As a part of the PhD data collection stage for Justin Brown, School of ......

Now that you have completed your learning materials for the week, I would ask you to fill in the same test as you took before the beginning of week 3. The purpose of this test is to see if there is any discernable difference between your entry score and your exit score.

As stated previously, the results of these tests will in no way affect your scores or evaluations within this unit or your course as a whole. Once again, please do not spend too much time deliberating on individual questions or researching them externally. Simply answer the questions you know, and take a best guess on those you are not so sure about.

Many thanks, Justin

1. Which of the following is a form submission method?

- ○ Get
- ○ Action
- ○ EncrypType
- ○ OnSubmit

2. On what port does HTTP transmit data over TCP/IP

- ○ 25
- ○ 80
- ○ 110
- ○ 143

3. A device that allows IP traffic to move between networks of different domain numbering is a

- ○ Gateway
- ○ Bridge
- ○ Hub
- ○ Router

4. To set the maximum amount of information that can be entered into text field you would use?

- ○ MaxSize
- ○ MaximumLen
- ○ MaxLength
- ○ A maximum length cannot be set using html

5. TCP operates on what layer of the internet model:

- ○ Internetwork
- ○ Network Interface and Network
- ○ Transport
- ○ Application

6. Which of the following protocols is most suited to stream meading applications over the WWW?
- ○ TCP
- ○ RDP
- ○ FTP
- ○ UDP
- ○ None of the above

7. Internet Protocol version 6 (IPv6) has a binary number range of?
- ○ 32 bits
- ○ 64 bits
- ○ 128 bits
- ○ 192 bits

8. A form checkbox can be used to send multiple values against a single field name:
- ○ True
- ○ False

9. The order in which the JavaScript function checks the field values must be the same order in which those fields appear in the form:
- ○ True
- ○ False

10. When a html form is submitted, the data in the form is sent to a location specified by the form:
- ○ Element
- ○ Target
- ○ Property
- ○ Action
- ○ None of the above

11. A Class A web address can allow how many hosts:
- ○ 254
- ○ 65 534
- ○ 16 777 214
- ○ None of the above

12. JavaScript form validation prevents any errors getting to the server-side scripting system:
- ○ True
- ○ False

13. Email services would be dealt with at which level of the OSI model:
- ○ Physical
- ○ Data Link
- ○ Application
- ○ Presentation
- ○ Network
- ○ Session
- ○ Transport

14. T1 connections run at what bandwidth:

- ○ 256Kbps
- ○ 512Kbps
- ○ 1.54Mbps
- ○ 20Mbps

15. Which of the following is most often used for client-side form validation:

- ○ JavaScript
- ○ VBscript
- ○ PHP
- ○ None of the above

16. A contentionless link is defined as:

- ○ A period of extremely low network traffic when no packet collision takes place
- ○ A direct cable connection between two network devices
- ○ A direct, virtual connection between two devices over the network
- ○ None of the above

17. It is only possible to change the background colour of a textfield using CSS:

- ○ True
- ○ False

18. The order in which the JavaScript function checks the field values must be the same order in which those fields appear in the form:

- ○ True
- ○ False

19. TCP/IP packets remain the size regardless of the networks they travel through, as the size must stay the same as that set by the transmitting source:

- ○ True
- ○ False

20. TCP/IP is a common method of referring to two different protocols that do very different jobs:

- ○ True
- ○ False

21. What Class of IP address would normally be used with a home network:

- ○ A
- ○ B
- ○ C
- ○ Private networks do not usually fall within recognised IP address classes

22. For web applications requiring accuracy of data delivery, the required protocol would be:

- ○ FTP
- ○ ARP
- ○ UDP
- ○ None of the above

23. An octect in network addressing refers to:

- ○ 1 byte of information
- ○ 64 bits of information
- ○ An address range measured from 0 to 255
- ○ None of the above

24. Routers are effectively invisible to the Internet Protocol, and intercept IP traffic rather than have IP traffic aimed at them:

- ○ True
- ○ False

25. The difference between using the *localhost* address and a *fully qualified* web address (url) is:

- ○ Localhost means the system will find the local address automatically without having to know it
- ○ Localhost will only run on the local machine, excluding outside connections
- ○ A web server can only operate in either localhost mode or fully qualified (external access) mode, not both at one
- ○ Localhost is just a pseudonym for 127.0.0.1

26. Some methods used to conserve IP address usage include:

- ○ Internal domain servers and private IP ranges
- ○ Intranets communicating with the open Internet using Network Address Translarion
- ○ Both of the above
- ○ Neither of the above

27. The technique used to process submitted form data on the server-side is referred to as:

- ○ CGI
- ○ FastCGI
- ○ Both of the above
- ○ Neither of the above

28. MTU is an acronym for:

- ○ Minimum Transferrable Unit
- ○ Maximum Transferrable Unit
- ○ Mean Time Until
- ○ Mean Total Upload

29. 127.0.0.0 is an example of what type of IP address class:

- ○ unallocated
- ○ Broadcast
- ○ Multicast
- ○ Loopback
- ○ Is not considered a member of a TCP/IP stack class

30. Within the confines of the Document Object Model, html forms cannot be changed dynamically with JavaScript:

- ○ True
- ○ False
- ○ They can, but only using Internet Explorer
- ○ None of the above

Student Survey - Common Questions (Both Groups)

Learning Systems Student Survey

As a part of the PhD data collection stage for Justin Brown, School of .....

The study you have participated in was designed to evaluate student attitudes to different methods of learning content delivery. We use the term learning content to refer to the files you download from the web and the information contained in those files. Your role in this study has been to perform your weekly studies as usual with the eLCMS, while at the same time providing this study with some performance and attitudinal data from that interaction with eLCMS.

1. Technology experience and access		SA	A	N	D	SD	NA
1.1	I am comfortable using computing technology	○	○	○	○	○	○
1.2	I classify myself as a competent user of computing technology	○	○	○	○	○	○
1.3	I mainly access the e-learning resources from						

- ○ home
- ○ work
- ○ university
- ○ all equally

2. E-Learning exprience		SA	A	N	D	SD	NA
2.1	I classify myself as a competent user of the eLCMS	○	○	○	○	○	○
2.2	I am experienced at using online learning systems	○	○	○	○	○	○
2.3	Aside from Ecourse, which of the following online learning systems have you used						

- ○ WebCT
- ○ Blackboard
- ○ Other [ ]

3. ECourse usage		SA	A	N	D	SD	NA
3.1	I print then read the resources provided on the eLCMS	○	○	○	○	○	○
3.2	I read the resources provided in the eLCMS straight from the screen	○	○	○	○	○	○
3.3	I find I can get through my units only using the eLCMS rarely	○	○	○	○	○	○
3.4	Where an entire semesters worth of content is available at the beginning of semester, I download all materials and rarely refer back to the ECourse system	○	○	○	○	○	○

4. Study practice		SA	A	N	D	SD	NA
4.1	My usual study practice is to work with the materials in the week presented	○	○	○	○	○	○
4.2	I complete all the weekly materials and activities in the week presented	○	○	○	○	○	○
4.3	I know how I learn best	○	○	○	○	○	○
4.4	I prefer to study at my own pace	○	○	○	○	○	○

5. List three (3) features you like *most* about the eLCMS

5.1

5.2

5.3

6. List three (3) features you like *least* about the eLCMS

6.1

6.2

6.3

Student Survey – Treatment Group Questions

7. Controlled content sequencing		SA	A	N	D	SD	NA
7.1	I like the way in which the CCS materials were structured and sequenced	○	○	○	○	○	○
7.2	I found the structure provided by CCS to be helpful in my understanding and comprehension of the weekly materials	○	○	○	○	○	○
7.3	I feel that CCS worked well in conjunction with class-based learning activities	○	○	○	○	○	○
7.4	CCS would be better suited to a fully online mode of study	○	○	○	○	○	○
7.5	The requirement to work through materials rather than download the whole weeks content at once does not bother me	○	○	○	○	○	○
7.6	I felt more confident working on the weekly materials knowing I was doing the work in the correct order	○	○	○	○	○	○
7.7	I found the constant assessment (tests) / feedback feature to be useful in gauging my learning performance	○	○	○	○	○	○
7.8	Which of the following content types do you think are best suited to CCS						

- ○ Lecture slides/notes
- ○ Readings
- ○ Workshop activities
- ○ Other ____________

8. ECourse and ECourseCS comparisons		SA	A	N	D	SD	NA
8.1	I prefer the usual eLCMS method of content structure and delivery	○	○	○	○	○	○
8.2	I feel a mixture of the eLCMS and CCS content delivery methods would be beneficial	○	○	○	○	○	○
8.3	I prefer to download all the materials and work on them at my own pace and in the sequence I feel comfortable with	○	○	○	○	○	○
8.4	I would like to see a system like CCS used in my other units	○	○	○	○	○	○

9. List three (3) features you like *most* about CCS

9.1 ____________

9.2 ____________

9.3 ____________

10. List three (3) features you like *least* about CCS

10.1 ____________

10.2 ____________

10.3 ____________

Staff Survey

Learning Systems Staff Survey

As a part of the PhD data collection stage for Justin Brown, School of ....

The research I am conducting is designed to examine staff and student attitudes to the controlled sequencing and delivery of content via web based Learning Content Management Systems, in this case the eLCMS. My research is examining the outcomes of controlling the way in which students access the weekly materials in systems like the eLCMS. By using controlled sequencing, unit authors could create a requirement that students complete course materials in a set sequence, with the sequence being controlled by author defined mechanisms, such as tests, multiple attempts at particular learning materials. The following online survey is completely anonymous, and is designed simply to gain information about staff attitudes to the concept of controlled sequencing and delivery of web based learning materials.

If you would like an account in the system, to see if from a student point of view, feel free to send me an email and I will send you back the system URL and login details.

Screenshots and descriptions of the system in use can be accessed here.

Teaching Experience / Details	
Primary teaching area (discipline)	
Number of years tertiary teaching experience	1
Number of units you are teaching this semester	0
-how many are online only?	0
-how many are on-campus only?	0
-how many are mixed-mode?	0
Gender	Male

	1. Ecourse teaching practice	SA	A	N	D	SD	NA
1.1	I have significant expertise in the online and e-learning field	○	○	○	○	○	○
1.2	I find I have had to change my teaching style to fit the Ecourse delivery method	○	○	○	○	○	○
1.3	Using Ecourse has reduced the time overhead of unit management	○	○	○	○	○	○
1.4	The features of Ecourse I use most heavily in my teaching include;						
a	Unit forums	○	○	○	○	○	○
b	Unit messages	○	○	○	○	○	○
c	Links to external, web based content	○	○	○	○	○	○
d	Online document delivery	○	○	○	○	○	○
e	Online assessment submission	○	○	○	○	○	○

1.5 Which of the following online learning systems have you used

- ○ WebCT
- ○ Blackboard
- ○ Other

		Yes	No
1.6	I usually place an entire semester worth of materials into Ecourse at the start of semester	○	○
1.7	I place materials into Ecourse on a week by week basis	○	○
1.8	I have had students complain to me early in the semester if all the semester materials are not available immediately	○	○

2. List three (3) features you like *most* about the ECourse system

2.1

2.2

2.3

3. List three (3) features you like *least* about the ECourse system

3.1

3.2

3.3

4. Controlled content sequencing		SA	A	N	D	SD	NA
4.1	I would like to have students work on materials in an order I have determined	○	○	○	○	○	○
4.2	I feel that a mixture of the Ecourse delivery method (click what you like) and controlled content sequencing (following a controlled sequence) might be better than using only one or the other	○	○	○	○	○	○
4.3	I think students taking my units would react well to controlled content sequencing	○	○	○	○	○	○
4.4	I believe that the following mechanisms would be appropriate to control sequencing of course content;						
a	quizzes / tests	○	○	○	○	○	○
b	number of attempts at tasks by a student	○	○	○	○	○	○
c	time spent on tasks by a student	○	○	○	○	○	○
d	displaying / hiding materials according to dates and times	○	○	○	○	○	○
e	interaction from a member of the teaching staff (such as a confirming that a student has placed a relevant message on a unit forum)	○	○	○	○	○	○
f	other						
4.5	I believe controlled sequencing;						
a	would be better suited to units delivered in a purely online mode	○	○	○	○	○	○
b	would be better suited to units delivered in a purely on campus mode	○	○	○	○	○	○
c	would work well in conjunction with my usual class based teaching activities (lectures/workshops)	○	○	○	○	○	○
d	would assist my students in their comprehension of the weekly topic(s)	○	○	○	○	○	○

5. List three (3) areas of your online teaching practice that could benefit from controlled content sequencing

5.1

5.2

5.3

6. List three (3) problems you could imagine arising from the use of controlled content sequencing in the delivery of online course materials

6.1

6.2

6.3

Appendix C – Recruitment and Communications

Student Participation Consent Forms

Researcher
Justin Brown
[redacted]

Principal Research Supervisor
[redacted]

Greetings,

I would like to invite you to participate in a research project that will form the data collection stage of my studies towards a PhD in Information Science. This study aims to develop innovative ways of delivering learning materials to students via the World Wide Web. Your unit has been selected due to the number of enrolled students and experience level of students (most have completed at *least* one year at university)

This research looks to test and evaluate a variation on the method you use to access your weekly learning materials using the eLCMS. Participation will involve completing some small online tests, working through your weekly materials as usual and filling in an online survey form. The research will be run over the period of one to two weeks and should involve no more than 3-5 hours spread over that week.

Non participation in this project will have no effect on your assessment results in either this unit or your university degree, and no record of non participants will be kept. Participation in this project is completely voluntary, and you may withdraw from participating at any stage in the project. The final results for publication in my thesis will be completely anonymous, and no record of your use of the system or test performance will be linked to your name or contact details. The data you provide in the online tests and surveys will be used to provide an understanding of students' use of, and attitudes towards the delivery method used in the research system. You may access the information collected about *your* use of the system at any time.
All those participating in this research will receive a complimentary movie ticket in acknowledgement of their time and effort.

If you have any questions or require any further information about the research project, please feel free to contact myself or my research supervisor on the above details. If you have any concerns or complaints about the research project and wish to talk to an independent person, you may contact:

Research Ethics Officer
[redacted]

I look forward to working with you on this project.

Yours truly,

Justin Brown

Research Project Student Participation Form

FIRST NAME:____

SURNAME: ____

AGE: _____

GENDER: Male [ ] Female [ ]

COURSE OF STUDY (i.e Bachelor Science Internet Computing): __________________

____

EMAIL ADDRESS (preferably student email address):___________________________

____

CONTACT PHONE NUMBER: ____

I have read the above information and am willing to participate in this research study.

I wish to be advised of the outcomes of this research: Yes [ ] No [ ]
I am willing to participate in an interview after the week 3 testing: Yes [ ] No [ ]

SIGNED: _________________________________ DATE: ____ / ____ / ________

Email to Control Group

Dear [redacted],

This email contains the account information for logging into my PhD research system to complete the week three materials in [redacted]. You have been allocated into the Control group for this study. The following link is to a Word document containing an explanation of what you need to do to complete the PhD participation items.

INSTRUCTIONS:

http://....................../elcms/ControlGroupGuidelines.doc

ACCOUNT DETAILS:

Your username is : User16

Your password is : random201

The address of the system is http://.........................../elcms

If you have any problems with the system, or do not understand something to do with the system, please do not hesitate to call me on [redacted], or email me at [redacted]

Once again, I am deeply appreciative of your participation and look forward to analysing the results of this study.

Many thanks,

Justin Brown.

Email to Treatment Group

Dear [redacted],

This email contains the account information for logging into my PhD research system to complete the week three materials in [redacted]. You have been allocated into the Treatment group for this study. The following link is to a Word document containing an explanation of what you need to do to complete the PhD participation items.

INSTRUCTIONS:

http://....................../ccs/TreatmentGroupGuidelines.doc

ACCOUNT DETAILS:

Your username is : User36

Your password is : random221

The address of the system is http://.........................../ccs

If you have any problems with the system, or do not understand something to do with the system, please do not hesitate to call me on [redacted], or email me at [redacted]

Once again, I am deeply appreciative of your participation and look forward to analysing the results of this study.

Many thanks,

Justin Brown.