Web Interactive Multimedia Technology in University Learning Environments

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Web Interactive Multimedia Technology in University Learning Environments

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Declaration

I certify that except where due acknowledgement have been made, the work is that of the author; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; and any editorial work carried out by a third party is acknowledge.

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Preface

The following papers were written as part of this research:

- Asma Md Ali, Joan Richardson. Web Interactive Multimedia Technology: State of the Art in Jasni Mohamad Zain, Wan Maseri Binti Wan Mohd, Eyas El-Qawasmeh (Eds.), Part III Communications in Computer and Information Science 181 Springer 2011, ISBN 978364 22220 23, p.41-53.
- Asma Md Ali, Joan Richardson. Web Interactive Multimedia Technology Evolution in Jianhong Zhou(Ed.), ASME Press 2011, ISBN 9780791859735.
- Asma Md Ali, Joan Richardson "Using Web Interactive Multimedia Technology: Several Approaches" paper submitted for the International Journal of Learning on April 2012.
- Asma Md Ali, Joan Richardson, "Web Interactive Multimedia Technology: Implementation from Two Perspectives", International Journal on New Computer Architectures and Their Applications (IJNCAA) 2(1): 154-166, The Society of Digital Information and Wireless Communications (ISSN: 2220-9085)2012.
- Asma Md Ali, Joan Richardson, "Web Interactive Multimedia Technology: State of the Art" International Conference on Software Engineering and Computer Science (ICSECS) 2011, Kuantan, Malaysia, *Proceedings*, Paper 342.
- Asma Md Ali, Joan Richardson, "Web Interactive Multimedia Technology Evolution" International Conference on Computer Engineering and Technology (ICCET) 2011, Kuala Lumpur, Malaysia. *Proceedings.* Paper T10049.
- Asma Md Ali, Joan Richardson, "Web Interactive Multimedia Technology Implementation: A University Context" UK Academy for Information Systems (UKAIS) International Conference 2012,*Proceedings*,Paper 37.
- Asma Md Ali, Joan Richardson, Peter Macauley, Evaluation on Web Interactive Multimedia Technology, Poster - Presented at RMIT Business Research Week 2011, RMIT University, Melbourne, Australia.
- Asma Md Ali, A Study on Web Interactive Multimedia Technology – Presented at ACIS 2009 Doctoral consortium, Monash University, Melbourne, Australia.

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Glossary

Term	Definition
Academic Developer	The university staff member who supports lecturers' use of Elluminate for learning and teaching activities. An academic developer's role is described as "to enhance your teaching with practical tips and assistance from colleagues working within the different schools on a range of topic…provides a range of support services to Schools, leads the continuous improvement in the design and delivery of programs and courses, and manages a range of strategic projects aimed at researching, contextualising and evaluating learning and teaching initiatives and activities" (RMIT University 2013a).
Affordances	An affordance is the discovery of possible actions in an interface. It refers to the qualities of an object or environment which allow an individual to perform an action. In this thesis, affordances refer to the features of Elluminate or other web interactive multimedia technology which are used by stakeholders to carry out tasks in learning activities. The term affordance has several meanings in the literature and there is no agreed understanding (Brown 2004). The word affordance was first used by J J Gibson, a perceptual psychologist, in 1966. The author later claimed: "The verb to afford is found in the dictionary, but the noun affordance is not. I have made it up. I mean by it something that refers to both the environment and the animal in a way that no existing term does" (Gibson 1979, p. 127).
Artefact	A construct, model, method or instantiation that could contribute to research knowledge (Hevner et al. 2004; March & Storey 2008). An artefact is the outcome of research in Design Science Research in Information Systems.
Blended learning environment/ blended learning	Mixed web and face-to-face interaction in a traditional classroom environment. "Blended environment" in this study refers to the combination of virtual and physical spaces for learning which is different than traditional classroom where the students and lecturer existed physically in the same room, the use of web technology in the classroom.
Elluminate	An exemplar of a web interactive multimedia technology. Elluminate (also referred to as e-Live or Elive) is web conferencing software which can be used in real-time for collaborative activities. Elluminate enables lecturers and students to have real-time discussions while viewing MS PowerPoint slides or websites.
Framework	"A structure made of parts joined to form a frame; esp. one designed to enclose or support; a frame or skeleton… In extended use: an essential or underlying structure; a provisional design, an outline; a conceptual scheme or system...an essential or underlying structure; a provisional design, an outline; a conceptual scheme or system" (Oxford English Dictionary).Frameworks can be represented in table format. Frameworks are also portrayed in diagrammatic form and are often referred to as models (Dix 2007).
Information Systems	A field of study that incorporate technology, societies and organisations (Oinas-Kukkonen 2010). Information Systems promotes multidisciplinary research as it involves the human and technical domains within one context.
Interactive	Web technology that is non-static, dynamic and responsive to user input. For example, technology that enables audio for a user to be able to talk to another user on the web allows interaction between the users.
Learning Activities	The activities which are stated in a subject guide prepared before a course starts to provide the scope of the subject for lecturers to design subject delivery and to guide the students, who are expected to do more self-directed learning in higher education institutions than in schools.

Lecturer	"A person who gives lectures esp. at university or college" (Longman Dictionary of Contemporary English 1987).The university academic who uses Elluminate to teach a subject. A lecturer's role is to "contribute to the teaching and research efforts of the school… teach across the undergraduate and postgraduate programs within the discipline…expected to conduct research and publish in relevant academic forums, while engaging in collaborative research projects with other members of the school" (RMIT University 2013b).
Model	"A representation of structure, and related senses…A summary, epitome, abstract; the argument of a literary work….A simplified or idealised description or conception of a particular system, situation, or process, often in mathematical terms, that is put forward as a basis for theoretical or empirical understanding, or for calculations, predictions, etc; a conceptual or mental representation of something…Mathematical model n. a description or representation of something conceived or presented in mathematical terms…a summary, epitome, abstract; the argument of a literary work…a simplified or idealised description or conception of a particular system, situation, or process, often in mathematical terms, that is put forward as a basis for theoretical or empirical understanding, or for calculations, predictions, etc; a conceptual or mental representation of something" (Oxford Dictionaries).
Multimedia	The combination of two or more media – audio, text, image, animation and video – provided within a single platform.
Student	"A person who is studying esp. at a place of education or training" (Longman Dictionary of Contemporary English 1987). A person who is enrolled in a subject at a higher education institution. Students can be enrolled to study at different levels (certificate, diploma and different levels of degrees) (RMIT University 2013c).
Usefulness	Usefulness is used to illustrate the practicality of the technology affordance to achieve the intended learning objective from the stakeholder's perspective.
Web 1.0	Traditional HTML web pages that are static (Linaje, Preciado & Sanchez-Figueroa 2007). The user just read the information displayed on the web pages and it is largely text. Users were passive consumers of content (Usluel & Mazman 2009).
Web 2.0	The web sites are dynamic where the information is created by the user to be shared on the Web which enable collaboration and self-publishing (Kennedy, Chang, Churchward, Gray, Judd, Waycott, Dalgarno, Bennett, Maton, Krause & Bishop 2007; Usluel & Mazman 2009).
Web Interactive Multimedia Technology	Systems that combine more than two media, responding to users' input and delivered/accessed through the internet. In this thesis, web interactive multimedia technology refers to technology such as Elluminate which is used on the web to conduct almost real-time sessions and for communication between lecturers and students to support students' learning.

Abstract

This research studies the implementation of Elluminate, a web interactive multimedia technology used for teaching in universities. Four higher education level subjects were used as case studies to gather qualitative data from a range of stakeholders. A Design Science Research in Information Systems approach underpinned the research model used to drive data collection. This approach ensures that a utility artefact is generated by the research. In this research, guidelines were derived to assist lecturers and academic developers to choose appropriate technology affordances during subject design. Assistance during the subject design phase when lecturers and academic developers are faced with emerging technologies, such as, Elluminate, new learning spaces and a range of group sizes is critical to delivery of successful learning activities.

The importance of Web 2.0 technologies to higher education institutions is undisputed. Trends towards blended classrooms, globalisation and students separated by geographical distance have influenced universities' decisions to adopt technologies that enable ready access to information, real-time interactivity and collaboration, in order to facilitate students' learning. The challenges for universities are to provide a continuous upgrade of information technology infrastructure and to enable fast adoption and implementation in the classroom. At times the rate of technology advancement and institutional adoption outstrips staff capacity to implement the technology affordances effectively in the learning and teaching environment. Hence, studying the use of Elluminate, technology affordances in learning activities in higher education, which is the central focus of this research, is a key to successful learning and teaching in universities.

This research provides a contribution to support decision making in subject design in the form of guidelines. The guidelines as an outcome of this research were built from the data analysis based on the Design Science Research framework (Venable 2006a). A Design Science approach required a theoretical underpinning to the research model that included the use of technology adoption theories and constructive alignment learning theory (Davis 1989; Rogers 2003; Biggs 1996). Stakeholders' opinions were considered to provide a holistic view of Elluminate implementation in universities.

1 Introduction

Information and communications technologies provide a promising approach to create a blended classroom for university learning environments (Virkus 2008). The marketplace for education has expanded geographically, physically and socially with the emergence of the web and social networking capacity, especially among the Y generation (Enonbun 2010). Technologies, such as instant messaging, blogs, wikis, learning management systems, Google Apps, iTunes and video, provide opportunities for improvement in learning outcomes through innovative delivery methods. Traditional lectures were presented in real-time on the web. As technologies became available lectures were recorded and applications such as MS PowerPoint made text and images available to support the transfer of information from the lecturer to the students.

The use of Web 2.0 technology offers many opportunities to create activities for students that enable information sharing and collaboration (Ajjan & Hartshorne 2008). The main aim of the use of technologies in higher education institutions is to facilitate learning. Although many experts tout the potential of web technologies or Web 2.0 to facilitate learning, formal evaluation and other evidence regarding successful or effective implementation are generally lacking (Ajjan & Hartshorne 2008). Technology also changes end-users' perspective of the world, as they follow market surges without considering the need to fit the technology to the required purpose (Postman 1992, 2004).

Implementation in an organisation is considered successful when most of the people adopt the technology change (Williams, Dwivedi, Lal & Schwarz 2009). The Information

Systems lifecycle comprised of five stages: planning, design, development, implementation and maintenance. This research is in the implementation stage. Technology adoption issues are important during each stage of the development cycle. Adoption is an important domain in understanding how to use Web 2.0 technologies to facilitate learning in higher education institutions (Irani, Themistocleous & Love 2003). During the design of curriculum and delivery modes, stakeholders' perspectives of the impact of emerging technology on their ability to operate within the Information System are taken into account. Organisational constraints to technology implementation and stakeholder opinions must both be taken into account to produce change in the work place that will be adopted (Waring 2001).

Web interactive multimedia technology is a group of Web 2.0 technologies that support real-time collaboration, co-authoring and open access to information on the web. Elluminate is an exemplar of a web technology that enables real-time collaboration with more than just a text-based facility. Elluminate is a web interactive multimedia application that is currently available free of charge to all Victorian educational institutions including kindergartens, primary schools, secondary schools, TAFE institutions and universities. State, independent and Catholic schools are included through the Knowledge Bank of the Department of Education and Early Childhood Development.

This thesis studies the uses of Elluminateaffordances in university subjects that facilitate learning. A number of emerging technologies adopted in universities contain a diverse range of technology features, such as, audio, text, video, instant messaging, wikis and blogs. Elluminate offer audio, text, video and instant messaging for real-time collaboration. In this thesis, the term 'affordance' is used to refer to the web technology

features and associated interactions actually used in learning environments. Elluminate affordances need to be studied in order to ascertain best-practice in higher education learning for particular learning activities. Identification of useful affordances prior to planning a class provides an opportunity to ensure an appropriate suite of resources for university learning activities is chosen. A number of devices support the use of web technologies that include computers, smart phones and tablets (John & Jenkins 2011). A number of technologies offer similar affordances that enable the end-user to collaborate using open-source information. Elluminate is a central server application that enables lecturers to communicate with other lecturers and students in almost real time. Learning activities can be conducted online and students can receive immediate feedback.

This thesis explores the technology adoption issues that many higher education institutions face during the implementation of Elluminate. Investigation of Elluminate implementation at the institutional level by all stakeholders provides possibilities to minimise organisational cost by minimising replication of effort by various interested parties (Parfenovics & Fletcher 2004). Investigation of the educational resource delivery method is also important when evaluating the use of web technology in higher education, in order to optimise the quality of the learning environment (Elgort 2005). The following chapters describe technology adoption and implementation by presenting the findings of an investigation of Elluminate use to deliver subjects on the web. Case studies explore technology adoption issues encountered in many higher education subjects when implementing Elluminate for learning.

The design of the case study evaluations conducted was based on a Design Science Research framework in Information Systems (Venable 2006a). Design Science Research

in Information Systems underpinned this research in order to create a useful artefact capable of fast-tracking adoption of the emerging technology affordances (Hevner, March, Jinsoo & Ram 2004; Kuechler & Vaishnavi 2008; Peffers, Tuunanen, Rothenberger & Chatterjee 2007; Venable 2010). The lens used to look at the affordances used in the web classroom sessions was based on a Design Science Research framework. Stakeholders were asked how useful affordances were to learning, as well as asked about the constraints. The subjects chosen as case studies were first examined to ensure their subjects were well designed according to Biggs's constructive alignment principles (Biggs 1996; Biggs & Tang 2007). The focus of this study was on the alignment of affordances used in learning activities, learning objectives and assessment, to identify delivery modes using Elluminate affordances that augmented traditional practice. Teaching schedules for all the subjects used as case studies were evaluated to check for evidence of constructional alignment (Biggs 1996; Biggs & Tang 2007). This study generated an artefact to guide lecturers and educational developers to choose technology affordances to augment the learning activities planned for delivery.

This qualitative research project incorporated an initial assessment of each case study to ensure quality in terms of the design of subject delivering on the potential to deliver specified learning outcomes. Stakeholders' opinion was collected in relation to the learning and teaching effectiveness of each affordance and the technological constraints to create an artefact (guidelines) that would improve implementation by supporting lecturers to embed technology use at the learning activity design stage. Through the use of a focused theory on constructive alignment (Biggs 1996; Biggs & Tang 2007), the technology acceptance model (Davis 1989; Venkatesh, Morris, Davis & Davis 2003), the diffusion of innovation theory (Rogers 2003), systems thinking (Waring 2001) and a

Design Science framework (Venable 2006a), a research model was constructed. The purpose of the artefact or guidelines to support decision making in subject or curriculum design when the learning environment includes Elluminate implementation was to improve current practice (Venable 2006a).

To understand the purpose, aim and significance of this research further, this chapter is organised into three sections. Section 1.1 describes the background and context of this research, the objectives and significance of this research are in Section 1.2 and finally the outline of this thesis is in Section 1.3.

1.1 Background and Context

Information and communications technology has continued to shape public and professional interactions with the emergence of the web technology where data is easily accessible (Ion & Vespan 2011). The challenge for lecturers is to change the curriculum resources, subject delivery and subject design to make best use of the technology. Web 2.0 has had an enormous impact on web applications and society due to features that provide a means for collaborative learning, open access to information and social networking (Kim 2011). For example, lecturers in higher education no longer provide hand-written notes for students attending traditional lectures, and even the use of MS PowerPoint slides is becoming less standard.

The ‘roll-out’ of emerging technologies remains costly and is often difficult to implement because of poor business requirements and Information Systems alignment at the

operational level (Althonayan & Papazafeiropoulou 2011). As systems start to be deployed, many organisations begin to realise that the systems fall short of their initial expectations (Wafa & Belkhamza 2012). The lack of alignment of technology and operational functionality during the design and implementation phases of the adoption of an emerging technology such as Elluminate acts as a constraint to successful practice change. However, the adoption and diffusion of emerging technologies are an imperative for organisations because of rapid change in stakeholder expectations. Lecturers and students expect to communicate at anytime and anyplace in real time (Andrews, Smyth, Tynan, Vale & Caladine 2008; Armstrong & Franklin 2008; Virkus 2008).

Higher education institutions need to meet stakeholders' expectations and challenges whilst implementing emerging technologies (Althonayan & Papazafeiropoulou 2011). The use of technology is an inevitable transition in higher education due to the growing student demand for flexible delivery of subject resources and interaction between lecturers and students outside traditional classrooms (Raj 2011). However, the adoption of technologies does not always result in successful implementation nor does it mean that the quality of education improves. Stakeholder knowledge of the technology and how to effectively use it in a learning and teaching environment and organisational constraints hinder successful implementation (Eom 2011). To address these issues, many universities encourage the use of Web 2.0 technologies (Dupin-Bryant 2012). The challenge is the focus of universities must change from asking whether or not technology should be used, to how to successfully adopt and diffuse technology to improve the quality of the learning environment.

Web 2.0 technologies such as iTunes, Flickr, YouTube and blogs look promising, for improving access to information and learning activities in higher education (Brown 2008; Hossain & Aydin 2011). There are studies on the impact of Web 2.0 on student learning and how to provide web interactive technologies that improve learning environments and are easily adopted by stakeholders (Yu, Yuen & Park 2012). There is a distinct lack of studies that evaluate emerging technologies in terms of lecturer assistance or specific technology features that improve learning (Lê& Le 2012). Elluminate in this study is an exemplar of an emerging web interactive multimedia technology developed for use in learning environments. When this study started, Elluminate was an independent licensed software application that operated using a centralised server. Elluminate was designed for use by education institutions and business organisations needing to deliver classes online and to collaborate in real-time. The software application operates on a Java platform that is a plug-in to browsers or Learning Management Systems. Elluminate is now part of the Blackboard Learning Management System often used in higher education institutions (ITS 2012).

Web technologies such as e-mail, subject websites and newsgroups have added value to traditional classroom knowledge delivery through the potential to add quality by increasing opportunities for interaction. Successful implementations of the technologies have impacted on subject delivery and design in many colleges and universities (Ajjan & Hartshorne 2008).Web 2.0 technologies, have emerged with the potential to further enhance higher education learning environments due to their capacity to support co-authoring, collaboration and open access. With the use of Web 2.0, students no longer access the web only for dissemination of subject resources; instead they access it to create

collective knowledge through social interactions (Waycott, Thompson &Richardson 2010). Currently, the use of Web 2.0 enables students to connect different pieces of information and create new information that can be shared with others (Richardson, Hamilton, Gray, Waycott & Thompson 2012).

Universities have begun to adopt technologies that support blended learning environments, which are defined as traditional classrooms in which web technologies are used. Web 2.0 technologies have the capacity to enrich the learning experience for young and old and to nurture life-long learning (Carchiolo, Longheu & Malgeri 2010). The group of Web 2.0 technologies such as Elluminate facilitate real-time collaboration and interactive information sharing using multimedia. Web interactive multimedia technology can enable large numbers of people to interact, collaborate and share content during an agreed period of time. Examples include Elluminate and Wimba. Web 2.0 technologies provide students with the option of completing a learning activity without physically attending a classroom at the university campus or attending a class and surfing the web to expand upon knowledge provided. Learning can be undertaken inside or outside the traditional classroom. Blended learning enables students' interaction with lecturers using Web 2.0 technology and self-study.

Lecturers as Stakeholders Adopting Emerging Technologies

Lecturers are an important group of stakeholders in a university in their role as practitioners who implement technology for effective learning (Elgort 2005). It is important for lecturers who would like to use technology in their classroom to understand how and when to use technology. For example, during a lecture in a web session using

Elluminate, the lecturer could use MS PowerPoint or a blank screen, audio or text, emoticons or polling. Students, another important group of stakeholders in a university, can be viewed as the customers who need to learn the subjects offered by the university.

Students' Capacity to Learn in Blended Environments

Today's students are described as digital natives who have functioned in a digital environment for most of their lives; as a result, technologies that faculty and staff typically see as revolutionary can be routine for students (Abrahams 2010; Hillier & Vogel 2003; John & Jenkins 2011). This cohort of students are also described as 'net generation', students who arrive at the university accustomed to using text messaging, telephones, e-mail, searching the internet and watching television or YouTube (Ebner, Lienhardt, Rohs, Meyer & Dafoulas 2010). The students can access information using multiple devices. They can also collaborate with their peers through Facebook and validate their learning online through assessment activities. They are ready for web learning to be delivered in flexible modes and for schedules which are not tied to set times and places. Current students have readily embraced emerging technologies for learning (Rosen & Nelson 2008). As the new generation uses Web 2.0 technologies such as web-cam for video conferencing and Facebook for social networking systems in their daily life they expect Learning Management Systems, such as, BlackBoard to support instant messaging and multimedia (Huang & Nakazawa 2010). Long-held learning beliefs and established educational methods should be reshaped in order to incorporate the benefits of Web 2.0, which has the potential to change the model for higher education from the traditional classroom framework to a web technology mode (Dupin-Bryant 2012; Waks 2007). The change is not an abrupt change for students as it does not require

them to learn how to use emerging Web 2.0 technologies. Students need to apply knowledge of how to use technology gained in their social life to Web 2.0 technologies implemented in blended learning environments. This represents a need to learn new uses of familiar technologies.

This research looked at the implementation stage in the Information Systems lifecycle (Waring 2001; Laudon & Laudon 1998). In the implementation stage, Elluminate was deployed in higher education institutions. In the case studies chosen for this research, the lecturers were early adopters of Elluminate and implemented the technology in the subjects they delivered. Students were required to learn the subject material within a limited time frame. Academic developers, lecturers and students were interviewed about their experiences of using Elluminate for lectures and tutorials. In order for the implementation to become a success, the lecturers and academic developers needed to adopt the system and implement it in their learning and teaching activities. The adoption and use of technology is a central theme of Information Systems research (Hevner et al. 2004). Web 2.0interactive multimedia technologies include information and communication technologies such as devices and systems that are perceived by stakeholders to be emerging technologies (Rogers 2003). This study focused on stakeholders' perspectives of the effective use of Elluminate affordances in learning and teaching environments.

As universities move ahead with emerging technologies, a guide for lecturers that helps them to design technology-supported delivery will help higher education institutions to avoid disruptive and costly problems as numerous lecturers use trial and error as an approach to discover the best uses of emerging technologies (Dykman & Davis 2008).

This research investigates the use of a web interactive multimedia technology to complete learning activities, at the level of affordances.

Information Systems evaluation is a challenging task. Lack of user support and involvement are among the key reasons for Information Systems project failure (Raza & Standing 2012). Established technology-based Information Systems adoption models such as the Technology Adoption Model (TAM) only consider technology adoption from an individual user's viewpoint (Davis 1989). TAM does not provide a mechanism to deal with multiple stakeholders' perspectives and their roles in a holistic framework in learning in higher education. TAM is technology focused and does not consider context. Stakeholder opinion is taken into consideration by TAM to determine the ease-of-use of a technology. Ease-of–use may be impacted on by the organisational infrastructure but this is considered as a fault of the technology, in terms of potential for adoption. The Design Science Research model uses stakeholders' perspectives in the same way as TAM but also includes consideration of the effective design of the subject and technology constraints (Davis 1989; Venable 2006a). There is also potential to inform students' expectations for technology use for learning (Morgan 2012). The outcome of this research is an artefact to guide lecturers' decision making of which web interactive multimedia technology affordances are useful for particular learning activities at the subject design stage.

1.2 Aim and Significance

The aim of this research is to add to knowledge in the adoption of Information Systems field, by using Design Science Research to look at the implementation of Elluminate in university learning environments. The broad aim of this research is to better understand the implementation of web technologies affordances in higher education from stakeholders' perspectives. This thesis investigates case studies on Elluminate implementation in subjects to develop guidelines for implementing technology affordances in learning activities. The guidelines developed will enhance the subject design phase and will be scaleable across subjects and Web 2.0 technologies.

By undertaking this research using case studies, the use of Elluminate affordances were identified. Lessons can be learnt from each particular early adoption of Elluminate aimed at augmenting the teaching of undergraduate and postgraduate subjects across a range of disciplines. The findings of the research provide opportunities to disseminate best practice and to ease adoption for lecturers through the implementation guidelines developed. The guidelines are like a recipe where lecturers can improvise to suit their subject's delivery choices. The Design Science Research model used to design data collection ensures that the guidelines are theoretically underpinned. Constructive alignment is used to validate the alignment of learning outcomes, activities and assessments in the case study subjects (Biggs 1996). The Technology Adoption Model is used to establish ease-of-use and usefulness of Elluminate in blended learning environments (Davis 1989). Evaluations of stakeholders' perspectives of the impact of the use of Elluminate affordances on the effectiveness of learning and teaching informed the guidelines for adoption developed by the research. The approach takes into consideration stakeholders' experiences whilst

evaluating Elluminate use holistically by including technology, organisation and people constraints in the analysis.

Design Science Research demands that research produces an artefact or utility theory that improves the current situation (Venable 2006b). A description of a current situation is not a sufficient outcome (Iivari & Venable 2009). This research studied the affordances used by lecturers and academic developers implementing software applications that enable web interactive multimedia, to support delivery of learning activities in university learning environments. This thesis used a case study methodology through the Design Science Research approach in Information Systems framework to analyse the use of Elluminate in subjects. The four subjects chosen for the research case studies were drawn from a range of disciplines. The common denominator and main driver for the case study choice was the use of Elluminate for learning activities.

The evaluation of the subject design against Biggs' (1996) constructivist alignment theory was conducted to ensure that the case studies chosen for investigation were good examples of pedagogically sound curriculum resources and delivery plans without considering the use of technology. The popularity of Massive Open Online Courses (MOOC) is based on a connectivist philosophy that supports each person learning different things through machines that are not necessarily tied to the expected learning outcomes. An example of a MOOC is Stanford University's 'Writing in the Sciences' subject at https://www.subjectra.org/subject/sciwrite. In an online subject such as this, students can register freely and then follow the materials given weekly by the lecturers in one semester. Students can also ask questions about the assignments. At the end of the subject, the materials are available online and there are no marks or acknowledgement

given to the students officially by the university. Emerging technologies support life-long learning and nurture a knowledge-based society (Butcher 2011; Redecker, Ala-Mutka, Bacigalupo, Ferrari & Punie 2009). However, this research focused on the constructivist philosophy that the learning outcome is important to direct the learning.

It is important to underscore the importance and significance of this research in the light of exponentially increasing costs globally and the growing trends of universities to implement web technology as a solution to stem such cost increases with debate on technology-driven pedagogy (Gosper, Malfroy, McKenzie & Rankine 2011). There are changes in the market place where students value the use of web technology in learning and demand videocast, electronic collaboration and access to a range of information and communication technology facilities (Porter 2010). This research serves to facilitate better and more effective uses of Web 2.0 technologies and thereby supports value-driven learning delivery. 'Web interactive multimedia technology' is a term used, in this thesis, to describe the set of Elluminate affordances investigated. The group of Elluminate affordances under investigation are also available in a myriad of combinations in other software applications. The actual Elluminate affordances investigated are:

- text that allows interactive chat or instant messaging in a public or private manner
- audio that enables audio conferencing with microphone and speaker control
- participants' profiles that enable the lecturer to enable or disable some affordances to the students
- video that enables video conferencing
- emoticons that enable the expression and receipt of attitudes or feelings

- hand raise that enables students to raise their hands with an ascending number allocated to each student in the order of raising hands
- recording that enables the web session to be recorded and displayed later
- editing tools such as writing, deleting and pointing tools
- a whiteboard that enables the end user to write on it or to display MS PowerPoint slides

1.3 Structure of the Thesis

The thesis is structured in six chapters. This chapter, Chapter 1, has provided an overview of the study and presented the research objective that guides this research, the research approach for achieving the goals shall be achieved and how the thesis contributes to research.

Chapter 2 presents a review of the literature on Information Systems adoption. The evolution of web interactive multimedia applications and associated affordance capability as representative of emerging technologies used in higher education is identified from the literature that could improve lectures for learning. It further explores the research theories. An overview of technology adoption issues in higher education is discussed. The common terms used in the analysis, including Web 2.0, web interactive multimedia technology, and affordances are defined. The Design Science Research framework developed to underpin the research model used in this thesis is derived from the Design Science Research in Information Systems. The model domains, which are Solution Technology Invention, Naturalistic Evaluation and Theory Building are explained.

Chapter 3 discusses in greater detail the approach taken in this research. It presents the chosen research approach and methods. The chosen interpretivist view and the qualitative method are justified in this chapter. Research design with data collection and data analysis is explained. Limitations of the research are also presented. This chapter also details the ethics considerations required for data collection purposes.

Chapter 4 presents the analysis and findings from the interview and document analysis highlighting themes within each domain. It includes within-case analysis and a cross-case analysis of four subjects which are neuroscience, business, foundation computing and consultancy. Each case comprises a review of the respective subject's background, from the perspectives of the Solution Technology Invention, Naturalistic Evaluation and Theory Building domains. The stakeholders involved in the data collection and analysis comprised academic developers, lecturers and students.

Chapter 5 covers the findings of the case-based analysis. It includes discussion describing how the findings support the research conceptual framework that comprises the three domains of Solution Technology Invention, Naturalistic Evaluation and Theory Building. The lessons learnt are presented, including a reflection on the use of Design Science as an approach that demands an artefact as an outcome.

Finally, Chapter 6 provides the conclusion and highlights the guidelines as the outcome of this research, other contributions of the study and suggestions for future research that arise from the study.

2 Literature Review

This chapter explores existing research and theory to provide an interpretative lens to explore the use of applications that enable the use of web interactive multimedia affordances in higher education. Implementation issues in higher education are investigated. A conceptual model underpinned by Design Science Research in Information Systems is developed based on the literature to guide the evaluation of the use of Elluminate affordances in learning activities. The following literature review serves to highlight the current gap in understanding the ways of using web technology affordances in higher education learning and teaching that illustrate the lack of guidance provided to lecturers and academic developers to support curriculum design during subject planning. For example, when a lecturer designs a subject, the lecturer may consider the technology in the subject design stage or during implementation. Currently, it is posited that decisions relating to the best use of the technology often occur during subject delivery, which creates a trial-and-error experience for early adopters.

Whilst individuals choose to adopt appropriate technologies for particular learning and teaching activities there is rarely a guide for matching chosen learning activities, delivery modes and technology affordances. A model or a guide that academic developers and lecturers could use to assist in requisite decision-making, irrespective of the technology tool or discipline would improve the rate of adoption. At the time of initial adoption, academic developers and lecturers often experience a lack of time and expertise, and fail to leverage the full potential of the emerging technology, which results in a misalignment in learning. Due to the complexities of this issue the literature is presented as follows:

- The web interactive multimedia technology affordances are described in Section 2.1, followed by

  - The history of affordance capability (Section 2.1.1)
  - The use of web technology applications in higher education (Section 2.1.2)
  - Web interactive multimedia technology potential to improve lectures (Section 2.1.3)
  - Organisational and academic implementation of Web 2.0 technology (Section 2.1.4)
- Technology adoption issues in higher education are explained in Section 2.2. this section include these issues:
  - Reliability of the technology (Section 2.2.1)
  - Change to suit new generation of students (Section 2.2.2)
  - Direction (guide) for implementation (Section 2.2.3)
  - Time for learning to use emerging technology (Section 2.2.4)
  - Incentive (lack of organisational support) (Section 2.2.5)
  - Attitude towards emerging technology (Section 2.2.6) and
  - Information technology skills or proficiency (Section 2.2.7)
- The adoption theories and how they relate to this study are described in Section 2.3. This section includes a description of the following theories :
  - Reasoned Action (Section 2.3.1),
  - Planned Behaviour (Section 2.3.2),
  - Technology Acceptance Model (Section 2.3.3),
  - Unified Theory of Acceptance and Use of Technology (Section 2.3.4) and
  - Diffusion of Innovation Theory (Section 2.3.5).
- Biggs's (1996) theory of constructional alignment is used to check the alignment of the intended learning objectives, the resources needed to deliver learning activities and assessment tasks that evidence the learning achieved. Section 2.3.6 describes this

theory and how it is used to assess potential subjects for the case studies in this research.

- Design Science Research in Information Systems is introduced in Section 2.4.
- The Design Science Research framework described in Section 2.5 is used as a guide to evaluate web interactive multimedia technology affordances in higher education learning. This framework underpins the research conceptual model developed for this study.
- The summary and the significance of this study based on the literature are presented in Section 2.6.

2.1 Web Interactive Multimedia Technology Affordances

Affordances in this research refer to the features used by the lecturers and students completing learning activities in university blended learning and teaching environments. In this research Elluminate affordances are used on the web to communicate in real-time sessions. The term affordance has a variety of meanings in the literature; there is little agreement with respect to the understanding of the use of the term but it is generally refers to the action that a technology allows or disallow (Brown, Stillman & Herbert 2004; Ignatiadis & Nandhakumar 2009). Zahidi, Mat Sin and Jamal (2011) refer to learning affordances to refer to the features provided in Facebook that could contribute to students' motivation to participate in the Facebook for learning. Ajjan and Hartshorne (2008) describe pedagogical affordances by referring to social bookmarking sites that enable collaboration between students that enabling storing and sharing of web addresses with others. Wettasinghe, Majal and Hasan (2009) use affordances to refer to online chat messages ability to provide real-time interaction, immediacy, motivation, and collaborative learning that were categorised into course content,

consensus-seeking, socialising, providing support and navigating the live classroom. In a study of the literature conducted by McLoughlin and Lee (2007), MySpace, Facebook and Friendster were examples of software applications that contained affordances that facilitated connectivity and social interaction, websites such as Del.icio.us, Furl and Digg contain affordances that enable collaborative information discovery and sharing, Really Simple Syndication (RSS) supports knowledge and information aggregation and content modification, and includes technologies that enable podcasting and vodcasting where audio and video content is aggregated. O'Riordan, Feller and Nagle (2012) categorised social affordances into social connectivity and social interactivity. Social connectivity refers to an individual's list of connections and profile page; social interactivity using comments, posts, e-mail, instant messaging and rating; and profile management to manage photos and image identity. Content affordances is categorised by O'Riordan, Feller and Nagle (2012) into content discovery using links, content sharing using word-of-mouth and content aggregation using media such as audio and visual.

The word affordance was used by a perceptual psychologist, J. J. Gibson who claimed that *"the verb to afford is found in the dictionary, but the noun affordance is not. I have made it up..."*, to refer to actionable properties between the world and an actor (Gibson 1979, p. 127).

O'Riordan, Feller & Nagle (2012) proposed the use of the affordance concept to measure the potential use of web technologies because both the features and associated human behaviour in a particular context were taken into account. This type of investigation was an improvement on counting the number of times a feature was used or describing the use of a feature in a single context. Technology affordances can share similar capabilities in different contexts (O'Riordan, Feller & Nagle 2012). For example, the text affordance can be used as a

chat medium between students or as a means to ask the lecturer questions or for the provision of assessment feedback.

A panel of experts at the European Conference on Information Systems 2012 (http://ecis2012files.esade.edu/) discussed the development of a theory of technology affordances for virtual collaboration (Malhotra & Majchrzak 2012). The use of web interactive multimedia technologies was considered a virtual collaboration affordance as they provide opportunities to communicate via the World Wide Web, rather than face-to-face. This thesis contributes to the current discussion of affordance use to remove geographical boundaries in the higher education learning and teaching context. Web interactive multimedia affordances used to conduct learning and teaching interactions in real-time, whilst removing traditional classroom boundaries, are evaluated in this thesis.

2.1.1 The History of Affordance Capability

Web technology based on a distributed hypertext system that allows for the dissemination of information across broad geographical boundaries, commenced years ago, subsequent to the development of early hypertext systems and the internet (Berners-Lee 1989). Today the World Wide Web hosts distributed servers providing concurrent access to stakeholders all around the world. Browsers are the platform for the applications' graphical user interfaces. HyperText Transfer Protocol (HTTP) provides a simple and effective communication layer and a standard for web browsers and servers to communicate.

The early web browser implemented a simple hypertext layer that enabled web pages to own links. The simple approach to hypertext depended on a stateless protocol of HTTP and

Hypertext Markup Language (HTML) (Gogulakrishnan, Thirumalaivasan, Nithiya 2013). The early web just allowed users to access text and images within documents. The early web performed as a closed hypertext system due to its restricted linking functionality. After 1990, the World Wide Web experienced a rapid growth with the development of web architecture and browsers. However, without interactive multimedia support, most web learning systems still use static HTML pages. The inclusion of a lecture in a HTML page only allows the information to be treated as text. Students learning in this environment are limited to reading the text. From 2004, the appearance of Web 2.0 allowed collaboration and interaction for multiple users in real time. Web 2.0 provides a platform for lecturers and students to explore interactive affordances that support learning and teaching activities (Gooding 2008).

In a Web 1.0 environment a hyperlink can be provided to a MS PowerPoint presentation that allows note taking and commentary, audio and video. Web 2.0 provides enhancements to the traditional online non-interactive learning and teaching environment (Ajjan & Hartshorne 2008). The main advantages of using web interactive multimedia technology for learning are to convey information quickly and effectively to all students and to allow for the interaction that has the potential to improve student engagement. Elluminate, the application investigated in this study, allows a lecture to be delivered as text or a using MS PowerPoint presentation and audio.The lecturer can also provide audio and a screen-board to facilitate students asking questions in writing or orally, in real-time.

2.1.2 Emerging Technologies Use in Higher Education

Web 1.0 refers to an online environment that includes one-way video-conferencing, e-mail, and discussion forums that provide the capacity for communication between stakeholders but

lacked the technological capabilities required to support interaction and collaboration. 'Web 2.0' is a term introduced to make a distinction from what then became labelled 'Web 1.0', and refers to dynamic websites that enable almost real-time interaction and collaboration between active stakeholders (Mazman & Usluel 2010). In a report by the Department of Education and Early Childhood Development Victoria (2010), Web 2.0 was defined as a range of technologies that allow stakeholders to access and contribute to websites and web-enabled events. Web 2.0 technologies enable active participation and collaboration, attributes which distinguish the technologies from earlier web functionality, which was largely read-only. The most common activities in Web 2.0 are blogging, wiki writing, social networking, audio or video podcasting, virtual world activities and social bookmarking (Gray, Waycott, Thompson, Clerehan, Sheard, Humilton & Richardson 2011; Usluel & Mazman 2009). Web 2.0 enables synchronous tools such as chat that provide real-time communication and collaboration in a same time, different place mode. The affordances allow people to communicate at a single point in time and at the same time. Open access and collaboration are thus enabled via Web 2.0.

If effectively implemented, Web 2.0 offers ways to enhance students' learning experiences and deepen students' engagement and collaboration (Gray et al. 2011). Lecturers and students can create shared narratives or resources that incorporate multimedia as well as digitised text (Richardson et al. 2012). Web 2.0 connects lecturers and students in distributed physical spaces and enables activities that support collaborative learning (Milne 2009). Learning activities enable students to construct knowledge that may not come from the lecturer's direct instruction (Richardson, Raider, Henschke & Jackling 2009).

This student-centred learning approach develops students as collaborators in the learning process. The immediate access that Web 2.0 provides to an increasing amount of knowledge, in both the disciplinary and future professional areas of students' supports opportunities for authentic and problem-orientated learning (Ginns & Ellis 2007). A study by López-Pérez, Pérez-López & Rodríguez-Ariza (2011) on Web 2.0 used learning outcomes and the students' perceptions regarding the blended learning activities performed in a general accounting subject in a higher education institution. The study involved a total of 17 groups, with 1431 students registered for the 2009–2010 academic year and found that it resulted in a reduction in student dropout rates. This implies that blended learning motivates students to continue learning. A second positive impact was a general improvement in performance evidenced by better exam marks for the cohort using Web 2.0 technologies (López-Pérez, Pérez-López & Rodríguez-Ariza 2011). Further research is needed in investigating how technologies could be better used to assist or encourage interactions between students and lecturers in university settings (Goodwin, Kennedy & Vetere 2010).

There is a need to continuously evaluate technology affordances and update operational guidelines to direct use (Attwell 2007). If particular affordances are accepted as important to the facilitation of web learning activities, there is a need to identify what makes some systems effective while others fail (Mendenhall & Johnson 2010). Williams and Chinn's (2009) study found that Web 2.0 usage was a fulfilling experience for both lecturers and students. In that study a Web 2.0 based experiential learning assignment was designed and implemented as a required component in an introductory sport management subject. Approximately 105 students in three subject areas participated in the study, by completing an assignment, in self-selected teams of five people. The interdisciplinary component was developed in partnership with the Management Information Systems faculty and with input from business partners who

were seeking to increase their own information technology literacy. The details of the assignment, some examples of student work and a description of how the project was evaluated both in terms of grading criteria and student assessment were shared. Multi-disciplinary teams using Web 2.0 affordances to complete assessment was found to improve student engagement as noted in both lecturers' and students' evaluations of the assignment (Williams & Chinn 2009).

Web interactive multimedia technology affordances must be intentionally incorporated in learning activities, as it does not just happen (Attwell 2007). A potential area for research is the association between stakeholders' perspectives of affordance usefulness for purpose and the actual use of the many affordances (Chou 2003; Davis 1989). This research aims to fill this gap by examining the use of technology affordances in Elluminate, stakeholders' perspectives of the usefulness of the technology and the technological constraints of the affordances used in learning and teaching in higher education.

2.1.3 Web Interactive Multimedia to Improve Lectures

Web 2.0 has also been found to be useful in improving lectures. Küfi and Özgür's (2009) study found that Web 2.0 affordances enabled collaborative learning and co-authoring of documents. They study teams of students that shared their learning experiences and discussed topics with each other in a professionally facilitated environment. Relationships built through conversations assisted learners to develop patterns of behaviour that supported lifelong learning (Küfi & Özgür 2009; Wang 2009).

In Gosper, Green, McNeil, Philips, Preston & Woo's (2008) study, there was also evidence that Lectopia, a web lecture technology, was used by students as a study tool to complement face-to-face lectures. Lectopia, is a technology that records and publishes lectures on the web, for students' future use (Gosper et al. 2008). Students reported using Lectopia to support their learning, as after class they could revise or check the notes they had taken during the class. Lectopia was used by students to check notes, review difficult concepts, prepare for exams and listen to missed lectures. Still to be answered, as mentioned by Gosper et al. (2008) are questions on how web technologies can be integrated into the delivery of a unit of study by adjusting the lecturing style and how a course can be delivered to make the most effective use of web-based lectures.

Gosper et al. (2008) studied Lectopia which had been used by four universities in Australia namely Macquarie University, Murdoch University, Flinders University and the University of Newcastle. Gosper et al.'s (2008) research investigated the use of audio recording technology and linear video technology of live lecture within Learning Management Systems (Blackboard and WebCT). Research was conducted using a case study approach involving a survey with the lecturers and students and interviews with volunteered students. Gosper et al.'s (2008) study looked at linear or recorded audio and video technology rather than a web interactive multimedia technology that provide immediate feedback.

Feedback received from staff and students who had used Lectopia raised questions relating to changes in teaching style and good teaching practice. The experiences of staff and students in the use of web technology indicated that the best way to support learning is the provision of opportunities for feedback and interaction rather than focussing purely on the dissemination of information to a large group. Activities were designed to support learning (rather than

delivery through interaction and feedback). Gosper et al.'s (2008) paper reported on studies confirming students' appreciation of the convenience and flexibility offered by the provision of online lectures in terms of time and remote access to lectures.

The exploration of the impact of Lectopia on learning and teaching is of interest to the higher education sector because of the increasing demand from students for flexible access to educational opportunities. Substantial financial investments have been made by institutions to support Lectopia adoption and implementation as it has the potential to substantially improve teaching practice and students' learning experiences. In the report by Gosper et al. (2008), Lectopia was used by the students and staff, with 76% students and 54% staff having generally positive experiences. However, there was a mis-match between the perceptions of Lectopia reported by students and staff in relation to the benefits for learning. Eighty percent of students agreed that Lectopia benefited their learning whilst 49% of staff reported perceived benefits to learning.

With increased demands posed by work and family commitments, one way to address students need for flexibility is to provide easy access to lecture recordings. In addition to the benefit of flexibility, the impact of these technologies is generally positive on students' learning (Williams &Fardon 2007). In McElroy and Blount's (2006) survey of 411 students on their usage of Lectopia, more than 75% of students agreed that iLecture enhanced the subject when compared to other subjects that did not use the technology. Soong, Chan, Cheers and Hu (2006) reported on a similar study conducted in Singapore, but with video-recorded lectures. In a survey of 1160 students, they found that 94.9% agreed that the video-recorded lectures were useful in relation to their studies. The most popular reasons for using video-recorded lectures were for viewing difficult parts of the lectures and for exam preparation.

It is useful to evaluate Web 2.0 systems to obtain a better understanding of the effectiveness of web multimedia delivery of learning activities. Elluminate is considered a Web 2.0 technology as it is a web software which can be used in real-time for collaborative activities (Department of Education and Early Childhood Development Victoria 2010). The application provides mixture of a tele-tutorial and virtual classroom functionality with additional affordances that would be assessed for usefulness in the higher education learning and teaching context in this study. Elluminate enables users to have real-time discussions while viewing MS PowerPoint slides or web sites. Classes can also be recorded for later playback in the same way as Lectopia operates. In addition Elluminate provides a whiteboard that is not available in Lectopia. The screen-board allows both lecturers and students to interact using text and graphics.

Affordances that support instant messaging and immediate feedback are also available, in Elluminate, via ad-hoc survey (polling) affordances and text chat. Evidence to date supports the fact that the effective use of technology in learning, teaching and curriculum design requires an informed understanding of the expectations of students, staff and institutions, along with preparation for and induction into the use of the technology, in order to foster positive learning and student outcomes (Krause & McEwen 2009). Educational theory also has an impact on learning and teaching as it drives the design of learning outcomes, activities and resources (Biggs 1996).

2.1.4 Organisational and Academic Implementation of Web 2.0 Technology

Web 2.0 technology is increasingly seen as an enabler of learning in a collaborative manner (Redecker et. al 2009). In Web 2.0, the understanding of user-centric design and the importance of usability in design is much greater acknowledged which assist the creation of better quality learning and teaching resources and research on the impact on learning (Ullrich, Borau, Luo, Tan, Shen &Shen 2008) There is an increasing recognition that successful learning requires not just quality content but an appropriate context that includes facilitation and understanding of the learner (Eklund, Kay & Lynch 2003).

In a study by Gosper et al. (2008), a small percentage of early adopter lecturers recorded lectures and made them available to students for revision and note checking. Institutional requirements for all lecturers to use Lectopia followed as students' believed that recording improved the quality of lectures. Students' also voiced expectations that material be made accessible in a variety of forms outside traditional classroom spaces. Most universities measure teaching quality from the student perspective (Dupin-Bryant 2012). Lecturers are also an important stakeholder to successfully implement emerging technologies and facilitate learning environment (Eklund, Kay & Lynch 2003).

Collaborative activities where students can use e-mail, forums, and bulletin boards to share and edit documents online arise as alternatives to the more rigid Learning Management Systems. Web 1.0 Learning Management systems enabled lecturers to upload MS PowerPoint presentations for student access, which facilitates one-to-many, one-way transfer of information. Affordances designed to enable communication and relationship building during student-student and lecturer-student collaborative learning activities have become commonplace in Web 2.0 applications, e.g. Facebook, Twitter, Myspace and Elluminate

(Gray et al. 2011). Collaboration with students renews the lecturer-student relationship whilst maintaining immediacy for questions and feedback (Mendenhall & Johnson 2010). Interpersonal collaboration and knowledge building are seen as being amongst the most effective ways for adults to learn (Totterman & Widen-Wulff 2009).

What lecturers and students did with the resources available during learning and teaching activities is explored in terms of the principles of constuctivism that should underpin the design of the delivered activities and assessments (Biggs1996). The focus of constructivism is the achievement of higher level learning by independent, self-reliant learners who can use a range of strategies to construct their own knowledge. A subject guide specifies learning objectives, activities and assessment tasks. The subject guide provides students with assistance in finding their pathway through learning resources. Students now expect access to lecture resources at any-time and any-place. An increasing number of students request flexible access to educational opportunities, and universities such as Open Universities Australia have invested heavily to meet this demand.

Elluminate, which provides web interactive multimedia affordances, facilitates opportunities for flexible delivery options and the creation of blended learning environments (Williams &Chinn 2009). Technological affordances that support improved lecturer-student and student-student interaction add to institutional good practice stories as case studies of individual uses of technology are described and disseminated (McEachron, Bach& Sualp 2012).

Elluminate allows lecturers to deliver asynchronous lectures to students who are logged onto the internet (Jiang, Yuan & Zeng 2009). Lecturers using the tool are not restricted to face-to-face lecturing as a range of other learning experiences become possible via available

affordances. Elluminate offers a range of positive possibilities in terms of different delivery modes that mitigate the obstacles of distance and time, such as, text (instant messaging), audio (chat), video conferencing, polling (immediate feedback), emoticons and a screen-board. However, the assessment of the uses of Elluminate affordances in higher education learning and teaching is largely untested (Marino & Hayes 2012).

Lim (2010) investigated students' perceptions of using Elluminate in higher education classes using online survey with 145 students. The study found that Elluminate enhanced the learning experience of the students as the students expressed satisfaction and excitement regarding the use of this emerging technology. The web sessions allow the students to clarify their doubts, and to resume studying with questions addressed, from a location of greatest convenience to themselves (Lim 2010). In this thesis the researcher seeks to understand the learning environment and learning activities that can be augmented by the use of Web 2.0 technology affordances. Learning is one of the core businesses activities in university environments and as such it is critical that the experience provided to students is of a good quality.

2.2 Technology Adoption Issues in Higher Education

Universities' organisational cultures provide academics with a large amount of autonomy with respect to delivery of teaching, as long as the student experience meets institutional performance expectations. This freedom in the learning and teaching space can enable resistance to change or the adoption of emerging technologies (Michael 2012). The culture presents a challenge to the implementation of technology advances that have the potential to improve learning and teaching (Alves & Uhomoibhi 2010). The major adoption issues are discussed in this section in terms of:

- technology reliability and robustness (Williams & Chinn 2009),
- resistance to pedagogical change required to effectively implement new technologies expected by the new generation of students (Alsaggaf, Hamilton & Harland 2012),
- institutional capacity to train or guide staff (Varghese 2007),
- institutional provision of time for staff to learn, trial and use emerging technology (Giardina 2010),
- incentives or organisational support (Bowen 2012),
- organisational cultural belief that technology will not improve teaching and learning quality (Arokiasamy 2012),
- information technology skill or proficiency with technology (Melville 2009).

All of these issues negatively influence the adoption of emerging technology in higher education. The converse can be evidenced where staff understand that the use of emerging technologies is expected by students and will improve their performance as measured by an institutional good teaching scale (Moulton, Iyer, Shortis, Vuthaluru& Xing 2011). At a program level, good teaching is measured by the Course Experience Survey delivered to students at the end of each course (Barber, Jones & Novak 2009). Course Experience Surveys have been developed from the Course Experience Questionnaire managed by Graduate Careers Australia (Molyneaux, Jollands & Jolly 2010). As students' expect flexibility in delivery and high levels of individual interaction, a lack of change at an operational level can negatively influence teaching performance. At an institutional level a Course Experience Questionnaire performance drives the provision of improved technology infrastructure.

2.2.1 Reliability of the Technology

A prevalent issue that prevents adoption of technology is the reliability (or rather lack of reliability) of the technology (Munguatosha, Muyinda & Lubega 2011). A study of a faculty's perspective in a university found that reliability of technology is the main issue preventing the adoption of emerging technology in learning (Butler & Sellbom 2002). Small information technology support service issues, such as software malfunctions, burned-out light bulbs, slow internet access and out-of-date software also impact on the adoption of emerging technologies (Butler & Sellbom 2002). Chang (2007) and Gosper et al. (2008) studied reasons for staff refusing to adopt Lectopia. Staff refusing to adopt Lectopia cited poor audio quality, a restriction on their ability to move around the classroom which restricted their capacity to interact, and a lack of consistent provision of services. For example, audio interference was a reason for not using Lectopia (Gosper et al. 2008). Increasingly a lack of reliable infrastructure to provide are liable power supply, insufficient internet connections, and a limited supply of computers are now being found to be major constraints to adoption (Munguatosha, Muyinda & Lubega 2011).

2.2.2 Change to Suit New Generation of Students

Another issue related to the adoption of technology for learning and teaching is the lack of change to suit the new generation of students (John & Jenkins 2011). The new generation of students is defined as consumers of emerging technology in their daily life. These students have access to devices such as smart phones that have web connectivity and they are skilled at using Web 2.0 technologies to enable social interaction and access to multimedia information (Mazman & Usluel 2010). These students have never experienced a world without

information and communications technology devices for personal use and are referred to as the net-generation. Other terms used to describe the current student cohort are digital natives, digital immigrants, screenagers, millenials and the gamer generation (Abrahams 2010; Hillier& Vogel2003; John & Jenkins 2011). These students are purported to have different expectations for information and access in relation to their studies than previous generations.

John and Jenkins's (2011) study described sub-groups within the net-generation. The study found a minority group use little technology and a majority group uses computer technology, phones and various other web technology applications. Although the net-generation is exposed to technology in daily life, they regularly use only those devices and technologies that meet their individual specific needs or purpose. In fact this group may use several devices or technologies to access Facebook. For example, one student may only use a laptop computer to access a personal e-mail address in yahoo, while another student might use a laptop or a desktop or a mobile phone to access a personal e-mail address in yahoo (https://maill.yahoo.com) or hotmail (https://hotmail.com) or gmail (https://gmail.com). The number of devices and combinations of devices used to support media needs, such as, games and movies is expanding.

Hillier and Vogel (2003) argue that digital natives require a new teaching and learning approach as they have grown up surrounded by technologies designed for personal everyday use. However, de Corbière and Rowe (2011) stated that there is no specific age range or generation at which the current learners should be called digital learners. The impact of technology on the way humans operate and the resultant expectations of users are not just the domain of one generation. Everyone has access to technology regardless of their age. There is still a need to study learning and teaching approaches designed to effectively use emerging

technologies to facilitate digital learners' needs. As the scope of the web has expanded, so has the scope of the user, so it is important to identify the best ways of incorporating technology into learning activities (Iivari, Isomäki & Pekkola 2010).

2.2.3 Direction (Guide) for Implementation

Lack of direction or guides for staff and students implementing new technologies in learning and teaching is common (Dykman & Davis 2008; Abrahams 2010). For example, sometimes when a higher education institution implements an emerging technology, lecturers are simply expected to use the new technology. Lecturers and students are usually given a technical manual which explains how to use each feature or they can search the solution to a question.

Lecturers may find software easy to use but are not aware of the changes to pedagogy and associated resources needed to conduct classes successfully on the web (Armstrong & Franklin 2008). The approach for aligning affordances and learning activities in a particular web session often requires a risky trial and error approach for early adopters (Hamid, Waycott, Chang & Kurnia 2011). There is a need to study how to adopt technology to facilitate learning rather than to focus on whether to adopt the technology or not (Abraham 2010). There is a scarcity of best practice guidelines designed to further facilitate the adoption of emerging technologies as tools for improving teaching and learning in higher education (Ajjan & Hartshorne 2008). This thesis is looking at generating information to fast track the adoption of useful affordances aligned with the characteristics of the learning and teaching environment.

2.2.4 Time for Learning to Use Emerging Technology

Doherty (2011) identified lack of time as an issue commonly preventing the adoption of emerging technologies in a university learning environment. Learning to use emerging technology requires time, particularly when there are no directions or guidelines. Lecturers must overcome a degree of uncertainty which requires tolerance for ambiguity to plan to embed the new delivery mode or interaction in their teaching. Time is considered the second most important constraint to adoption after reliability (or rather, lack of reliability) of the technology (Butler & Sellbom 2002). There is also potential to waste a great deal of time creating curriculum resources using affordances that will not work in a particular class due to organisational infrastructure constraints. This has become an important issue in higher education institutions which focus on research rather than on teaching and learning activities (Doherty 2011). The pressure on lecturers to undertake research adds to already time-poor days and competes with time required to innovate by using emerging technology in teaching and learning activities (Abrahams 2010).

2.2.5 Incentive (Organisational Support)

An issue in research-intensive universities where the support is given more to research activities than to teaching is the lack of support for innovative teaching practice (Doherty 2011). This is the case in research-based higher education institutions rather than in teaching-based higher education institutions (Wildavsky & Litan 2011; Conole & Panagiota`Alevizou 2010).

Butler and Sellbom (2002) found that stakeholders in a university environment were dissatisfied with responses to information and communications technologies problems. Staff implementing emerging technologies reported the challenge of adopting emerging technology affordances in the classroom. Complaints during the implementation phase related to the lack of competent technical staff; poor communication between technical personnel and users; irrelevant information and communications technologies policies, lack of exposure to emerging technologies and the potential for learning and teaching improvements; and irregular professional training for technical staff (Munguatosha, Muyinda&Lubega 2011).

2.2.6 Attitude towards Emerging Technology

Postman (1992) used the term 'technopoly' to refer to the belief that information is at the heart of all problems and new information and communication technologies are the key to all solutions. 'Technopoly is the state of culture. It is also a state of mind. It consists in the deification of technology, which means that the culture seeks its authorisation in technology, finds its satisfactions in technology, and takes its orders from technology'(Postman 1992, p.71). 'Deification' is defined as 'make a god of' in the sense of 'treat as an object of worship' (Longman Dictionary of Contemporary English 1987). This means that 'technopoly', refers to upholding technology to a property of God, which is related to belief. For example someone asks something from technology instead of God first.

Regarding the use of technology, Postman (1992) divided users into three categories. The first group believe that technology is everything; without it life is not complete and in fact they could not survive; life is not complete without technology. For example, a student without an iPhone is considered not just a less competent student but a less competent human being. The

second group believes that technology is a tool to solve problems and support them in their work. Organisations often view technology as a cost that must be used in Information Systems to improve products and service to justify acquisition. This institutional view mirrors Postman's description of technology as a tool. The third group rejects technology and resists using it. Postman (1992, 2004) used the term "Luddite" to refer to this group. This minority group resists change and uses acceptable excuses, such as, a lack of software application reliability to validate refusal to adopt.

2.2.7 Information Technology Skills or Proficiency

There is lack of professional development and training urgency as most university lecturers believe themselves proficient with regard to technology use for learning and teaching (Butler & Sellbom 2002). Emerging technologies call for a change in skills. Butler and Sellbom's (2002) study examines at academic levels of proficiency with presentation software, graphics software, internet browsing and spread-sheets. It was found that most lecturers considered themselves suitably proficient. However, the capacity to self-teach and the understanding of requisite levels of proficiency was found to be better understood by Information Systems professionals than lecturers (Landry et al. 2008).

2.3 Web Interactive Multimedia Technology Adoption in Learning

Research in Information Systems requires a multidisciplinary approach as it involves the human and technical domain within one context and can also draw on theoretical and practical implications for actual business activities and organisation (Oliveira 2012). Social-technical or human technology has been a central issue for Information Systems research as a whole

(Oinas-Kukkonen 2010). The social and technical domains are studied in Information Systems research to yield theoretical and practical contributions for business and organisations (Gable 2008). One of the business activities of universities is learning, and research requires an understanding of people's interaction with emerging technologies, as well as each other.

The Information Systems development life cycle involves the following stages (adapted from Hoffer, George & Valacich 2002; Whitten, Bentley & Barlow 2002):

- Planning -Systems investigation: the requirements and concepts are defined to get deliverable decisions based on business needs;
- Analysis -Systems analysis: the requirement and concepts are analysed from the point of view of the end stakeholder (deliverable stakeholder requirements). The primary outputs for this phase are the system request and the feasibility study;
- Design -Systems design: the architecture of the hardware, software and data resources is defined. Coding is completed. The primary outputs for this phase are the system proposal and the system specification;
- Development -Programming and testing: the system is tested for functionality and whether it answers the need of the organisation;
- Implementation: The system is implemented in actual operation. The primary output for this phase is the installed system; and
- Maintenance -Operation and maintenance: regular evaluation and maintenance are required to make sure the product meets the needs of the organisation. The primary output for this phase is the continuing operation of the system.

Pre-adoption refers to refinement of a web interactive multimedia affordance at the Information Systems design and development stage and post-adoption refers to refinement throughout the maintenance stage. Terms like post-adoption, acceptance and implementation are used interchangeably in the literature. The adoption and use of technology is a central theme of Information Systems research that includes information and communication technologies such as devices and systems that are perceived by stakeholders to be new (Rogers 2003; Hevner et al. 2004). This study focuses on effective adoption of technology affordances by universities. This study examines the post-adoption phase of the implementation of Elluminate and explores how specific affordances were used to achieve to facilitate learning in a university learning context.

The adoption of Elluminate in a higher education context differs from the adoption of traditional Information Systems (e.g. Management Information Systems, end-stakeholder computing) in at least two ways. First, the decision to design the delivery of a subject using web interactive multimedia technology affordances is difficult for early adopters. Elluminate can be deemed emerging, which then categorises participants of this study as early adopters (Rogers 2003). A range of software applications and associated affordances are readily available for lecturers to augment the delivery of educational materials. Emerging technologies, such as, discussion boards, blogs, wikis, Twitter and Facebook provide a wide variety of affordances available within Lecture Management Systems. Second, the Web 2.0 interactive multimedia technology evolution offers new affordances compared to previous generations of text-based technologies available in Web 1.0 applications. However, research investigating the implementation of web technology focusing on the affordances used for learning activities and assessments is still needed (Attwell 2007). There is a need to support early adopters to implement affordances. Web 2.0 technologies provide a diverse array of

affordances. Often on software application incorporates more than one affordance and allows more than one affordance to be used at the same time to facilitate student-student and lecturer-student interactivity. Using web interactive multimedia technology, communication between stakeholders is not constrained by physical distance or time (Md Ali & Richardson 2011a).

A study on understanding the adoption of new ideas and new technologies is important. Available web interactive multimedia technologies and university curricula are subject to continual rapid change. It is important for staff to keep up to date and continue to change delivery modes for learning activities and assessments to meet changing students' expectations. When new ideas or new technologies become available, it is not a foregone conclusion that they will automatically be adopted in the blended classroom. Figure 2.1 illustrates the progression from considering the use of a technology based on an understanding of the potential affordances available, to planning the implementation of the technology for learning activities and assessments. The actual use of technology is based on individual intentions to use an affordance, for a given purpose. Stakeholder reactions to using an affordance are dependent on individual perceptions of its usefulness and ease-of-use (Davis 1989). This means that when an affordance is introduced with a new idea or technology, an individual will have a positive or negative reaction and this will influence the intention to use or reject the technology (Masrom & Hussein 2008). The investigation of all stakeholders' perspectives of the potential of technology to improve work underpins the assessments of the potential for adoption.

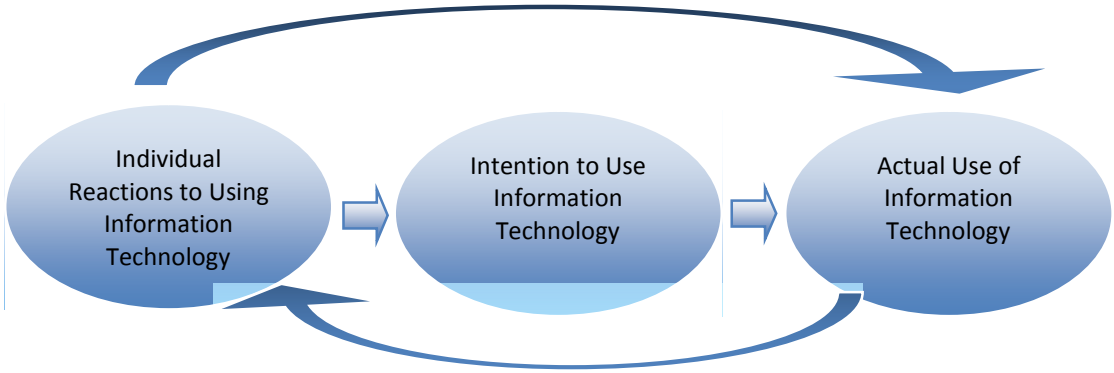

Figure 2.1: Basic concepts underlying stakeholder acceptance model (adopted from Masrom& Hussein 2008)

The basic concept that underlies the research on acceptance, adoption, diffusion and use of technology is summarised in Figure 2.1. In this thesis, the following five prominent technology adoption and diffusion models are reviewed and discussed:

(i) Theory of Reasoned Action (Fishbein & Ajzen 1981),
(ii) Theory of Planned Behaviour (Ajzen 1985),
(iii) Technology Acceptance Model (Davis 1989),
(iv) Unified Theory of Acceptance and Use of Technology (Venkatesh et al. 2003), and
(v) Diffusion of Innovation (Rogers 2003).

2.3.1 Theory of Reasoned Action (TRA) - Fishbein and Ajzen (1981)

The foundation of the Theory of Reasoned Action conceptual framework is provided by the distinction between beliefs, attitudes, intentions and behaviour (Fishbein& Ajzen 1981). A person's actual behaviour or use of a technology affordance is determined by their intention to use the technology to perform an action. The intention to use a technology for a planned purpose is jointly determined by the person's attitude and subjective norms concerning the associated behaviour (Ajjan & Hartshorne 2008). For example a person's intention to go to a movie theatre may not be realised due to a lack of money, feeling lazy or a partner

encouraging the person not to attend a particular movie due to poor reviews. This research does not observe behaviour but does question the reasons for chosen actions.

2.3.2 Theory of Planned Behaviour (TPB) - (Ajzen, 1985)

The Theory of Planned Behaviour (TPB) is based on the Theory of Reasoned Action (TRA) (Ajzen 1985; Ajzen1991). The intention to use is determined by three things: attitude, subjective norm and perceived behavioural control. The major difference between TRA and TPB is the addition in TPB of a third determinant for the intention to use: perceived behavioural control. Perceived behavioural control is determined by two factors: control beliefs and perceived power. Perceived behavioural control indicates that a person's motivation is influenced by how difficult the behaviour is perceived to be, as well as the perception of how successfully the individual can or cannot perform the activity. For example, if a person intended to send an e-mail but did not have the ability to complete the activity they would not send the e-mail. In the Naturalistic Evaluation domain of the Design Science Research conceptual model underpinning the data collection in this thesis, stakeholders' perspectives of use are documented. Stakeholders' intention to use an affordance for conducting learning activities such as using audio to present a lecture is documented. As the research is conducted in the post-implementation phase, any constraints to following through with the planned action are also documented.

2.3.3 Technology Acceptance Model (TAM)

Davis (1989) adapted the Theory of Reasoned Action (TRA) to describe a view of technology acceptance and adoption behaviour (refer Table 2.1). Two main determinants for an individual's behavioural intention to use an Information System were identified. The two drivers or constraints for adoption are perceived usefulness and perceived ease-of-use. The model further assumes a direct relationship between ease-of-use and usefulness. People may perceive a technology to be more useful when it is easy to operate. In this study, ease-of-use and usefulness are investigated as well as the subjects' curriculum design based on constructive alignment and organisational constraints, such as, class size and technical infrastructure (Biggs& Tang 2007).

The Technology Acceptance Model (TAM) has become one of the most widely used and empirically validated models within Information Systems research (Walsh 2007; Peffers et al. 2007; Wang, Xia & Fang 2007; Huang, Rauch & Liaw 2010; Lin 2008; Burke, Wang, Wan & Diana 2002; Hwang & Lockwood 2006; Fisher 2010; Mitchell 2003). TAM is considered to be a reliable and simple model for predicting and explaining stakeholder acceptance or adoption of technology (Venkatesh, Davis & Morris 2007). TAM is usually chosen because of its simplicity and applicability to information technology systems. However, clear-cut definitions of perceived usefulness and perceived ease-of-use are difficult to establish, and this confusion results in an ambiguous relationship between the items, as well as, incompleteness and lack of practical application, as a fundamental theory (Bagozzi 2007).

A major drawback for use of TAM to predict adoption is the lack of investigation of the context in which the technology is to be adopted. Technical infrastructure, software reliability

and cultural influences on adoption are not considered as components in the prediction of adoption success (Benbasat & Barki 2007; Goodhue 2007; Bagozzi 2007). Despite those problems, TAM has had a huge impact on the development of Information Systems research (Walsh 2007; Peffers et al. 2007; Wang, Xia & Fang 2007; Huang, Rauch & Liaw 2010; Lin 2008; Burke, Wang, Wan & Diana 2002; Hwang & Lockwood 2006; Fisher 2010; Mitchell 2003). It provides an integrated theoretical basis as a compact and simple model (Venkatesh, Davis & Morris 2007).

The Technology Acceptance Model (TAM) is a widely accepted technology adoption model used in very different settings, for example to test the acceptance of internet utilisation behaviour, video games, web ATMs in the e-payment industry, online learning activities, multimedia learning and social networking (Tsung-Yu & Yu-Ling 2009; Bourgonjon, Valcke, Soetaert & Schellens et al. 2010; Watson, Mong & Harris 2010; Tsai, Huang, Liu, Tsaur & Lin 2010; Yardi & Poole 2009;Weiqin 2009).

Recent studies suggest that the Technology Acceptance Model (TAM) can also be applied to education and to the adoption of web technology (Shroff, Deneen & Ng 2011). Studies have demonstrated the use of TAM in evaluations of areas, such as, the introduction of learning management systems and predictions of web-based information access in higher education (Beevi & Deivasigamani 2011). Although an abundance of studies aimed at extending the understanding of user adoption of Web 2.0 technology have been conducted, the researcher did not find studies on Web 2.0 technology that were conducted to facilitate subject design (Saeed & Sinnappan 2011; Shroff, Deneen & Ng 2011).

This study is interested in exploring the use of affordances for learning activities and assessment in the post-implementation phase of the adoption of an emerging technology. The main focus of the study is not the prediction of whether an affordance will be widely adopted but how guidance can be provided to support effective adoption. This study does not measure stakeholders' attitude toward the adoption of Elluminate affordances. The research holistically investigates the adoption of Elluminate affordances in learning activities. Bigg's (1996) theory was used as a lens to indicate the quality of the alignment of learning outcomes, learning activities and assessments prior to obtaining stakeholders' perspectives of the learning environment augmented by the use of new technology affordances.

2.3.4 Unified Theory of Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT) proposed by Venkatesh et al. (2003) and referred to in Table 2.1 extends TAM to take into account four determinants - performance expectancy, effort expectancy, social influence and facilitating conditions - that influence behavioural intention to use and ultimately the actual use of technology. The model was based on conceptual and empirical similarities across eight prominent competing technology acceptance models (Venkatesh et al. 2003). The facilitating condition is defined as the degree to which an individual believes that an organisational and technical infrastructure exists to support the use of the system (Venkatesh et al. 2003). Individuals are deciding whether to join Postman's (1992) second group that believe technology is a tool that will support them in their work.

2.3.5 Diffusion of Innovation Model (DIM)

The Diffusion of Innovation Theory created by Rogers (2003) and referred to in Table 2.1 determined five innovation characteristics that affect adoption. These were relative advantage, complexity, compatibility, trialling and observation (Rogers 2003). The overall theory is rich because it contains predictions regarding the spread of an innovation through a social system, i.e., the diffusion process, which follows an S-shaped curve (Rogers 2003). The S-shaped curve of cumulative adopters gives rise to a bell-shaped distribution of adopters to distinguish between five categories: 1) innovators, 2) early adopters, 3) early majority, 4) late majority and 5) laggards. These categories of user refer to the rate of adopting an emerging technology that is compatible with socio-cultural values and belief systems of adopters (Postman 1992). Postman categorised technology users into three categories in terms of their belief that relates to the purpose of adopting an emerging technology. “Laggards” was used by Rogers (2003) and Postman (2004) to refer to the group of users who reject and refuse to use an emerging technology.

Empirical research has supported the applicability of the Diffusion of Innovation Theory in predicting the adoption of various Information Systems, such as, the adoption and diffusion of online recruiting technology, tablet devices and a tourism website for bookings (Deumert & Spratt 2005; Farris 2011; Mallat 2007). The Diffusion of Innovation Model (DIM) suggests that the rate of an innovation’s diffusion is dependent upon the innovation’s relative advantage, complexity, compatibility, trialability and observability (Rogers 2003). The theory suggests that new technology should be compatible with current practice (e.g. Blackboard deliberately uses images from conventional physical learning blackboard, notes, pen etc). The theory also suggests that an idea can be adopted either when it reaches critical mass in a

particular social group or if it is seen to be new and exciting. An innovation spreads slowly at first and then picks up speed as more and more people adopt it. Eventually it reaches saturation level, where virtually everyone who is going to adopt the innovation has done so.

Table 2.1 summarises the five theories in the study of technology adoption that have been covered in this section.

Table 2.1: Summary of five technology theories in the study of technology adoption

Theory	Perspective
Theory of reasoned action (TRA)	The distinction between beliefs, attitudes, intentions and behaviour become the basis for other models.
Theory of planned behaviour (TPB)	The stakeholder has control of the intention to use.
Technology acceptance model (TAM)	The usefulness and ease-of-use of the technology determine the intention to use.
Unified theory of acceptance and use of technology (UTAUT)	This model adds the social influence and cognitive instrumental processes.
Diffusion of innovation model (DIM)	This model further categorises the stakeholders into early adopters and others.

If one takes a broader view, the use of Information Systems is often set within a specific system or context, such as, a university learning context. According to Elgort (2005), the effective use of technology for learning as an educational and technology innovation requires re-conceptualisation of the traditional learning paradigm, especially in relation to the roles of lecturers and students. To realise its potential, effective environments that facilitate learning need to be constructed where the lecturers need to explicitly express their intentions and beliefs (Elgort 2005).

2.3.6 Web 2.0 Augments Delivery of Well Designed Curricula

Learning theories are categorised into four types: behaviourism, cognitivism, constructivism and connectivism (Ally 2008; Ertmer & Newby 1993). Behaviourism focuses on external

stimuli and responses driving learning (Moore 2010). For example, when a person is given an external stimulus such as an extra mark, then that person is encouraged and their learning is reinforced. A behaviourist perspective allows an event to be examined as if the person involved in the interaction was a black box. Behaviourism is related to motivation (Workman 2010). A cognitive perspective on the same learning event would focus on the person and their reasons for each decision. In cognitivism, a person's reasoning and prior explicit knowledge are important (Wu, Chiou, Kao, Alex Hu & Huang 2012). Cognitivism focuses on the mental reasoning of a person. Academics using this approach to design subjects would focus on leading students along an easy, logical pathway to the desired learning outcomes (Hassan 2011). Connectivism proposes that people can be connected to machines that will require them to complete activities designed to deliver the required skills to achieve a specified learning outcome. There may or may not be associated assessment or certification (Pettenati & Cigognini 2007). It focuses on a person using social networking and maintaining connection and interaction to develop learning (Dunaway 2011). MOOCs are an example of connectivism driven curriculum development and delivery. Constructivism allows a focus on a learner's own effort to construct their own learning journey (DeCoux Hampton 2012). A shift away from the creation of teacher-centred learning activities to resources and activities that are student-centred is required to enable a constructivist learning environment (Smart, Witt & Scott 2012). Constructivism focuses on the learning that an individual builds based on their personal experiences (Hassan 2011). Constructivism is widely used in higher education institutions as a tool to design and evaluate subjects (Ceja Oseguera, Rivero-Villar, Ramírez Murillo& de la Torre Hidalgo 2012). The four learning theories reviewed, are summarised in Table 2.2.

Table 2.2 : Summary of the learning theories (adapted from Ally 2008; Ertmer & Newby 1993)

Types	Perspective
Behaviourism	Focus on external stimuli
Cognitivism	Focus on the process in the mind
Connectivism	Forward concept that machines can do the learning.
Constructivism	Focus on learner's own effort to meet expectation; aligning student learning with lecturer's expectation: constructive alignment

The constructivist approach to learning describes a learning process where students work individually or in small groups to explore, investigate and solve problems. Students become actively engaged in seeking knowledge and information rather than operating in a passive manner which may have been the preferred method of interacting in a traditional lecture (Smart, Witt & Scott 2012). In a traditional learning environment, the lecturer tends to emphasise factual knowledge and to focus on knowledge content (Luckie, Aubry, Marengo, Rivkin, Foos & Maleszewski 2012). Students generally do not interact and are required to acquire the knowledge delivered. The learning mode tends to be passive and the students do not interact with the lecturer during the learning process. In a blended learning environment, the lecturer becomes a facilitator that encouraged the students to explore other resources.

The process of learning involves the construction of meanings by the student from what is said, demonstrated and experienced (Allen 2008). The role of the lecturer is one of facilitating the development of understanding by selecting appropriate experiences and then facilitating students' reflective practice (Saadé & Kira 2004). Construction of meaning is a continuous and active process (Sesen & Tarhan 2011). Having constructed meanings, students can then evaluate and consequently accept or reject what they have learnt (Walker, Shore & French 2011). The constructivist approach to design and delivery of curriculum resources lends itself to the use of web multimedia interactive affordances that remove the traditional physical boundaries of the classroom.

Constructivism, in particular constructive alignment, is relevant to this research as it can be used to evaluate the alignment of a lecturer's designed learning outcomes prescribed activities and assessments. The addition of Elluminate affordances to augment delivery can enhance student's capacity to construct their own learning, as the technology supports interaction and any-time, any-place participation in learning activities. A constructivist approach suggests that learners create meaning from learning activities and assessments that is influenced by their existing knowledge and experiences (Ültanır 2012).

The lecturer needs to provide clearly identified goals and objectives for the subject in order to support a constructivist approach to student learning. Learning outcomes, goals or objectives are usually described in subject outlines that include a guide to the order and pace at which learning activities and assessments should be completed during a semester. A list of references and web resources available to support delivery is also usually included in the subject outline.

Biggs' (1996) theory has provided principles for subject design in higher education (Walsha 2010). The traditional lecturer-centric method of teaching has undergone change and there is an increasing expectation that lecturers will facilitate interaction, which the web interactive multimedia affordances also facilitate (Neo & Kian 2003; Attwell 2007). The use of constructive alignment, the method of teaching has facilitated a movement towards a student-centric focus. Lecturers still need to design the subject and facilitate students' learning. As it becomes easier for students to interact with their peers and the resources outside the boundaries of the traditional classroom, due to technologies, such as Elluminate; subject design becomes a critical component of course delivery. The students are able to use the

subject design as a guide to support their learning and hence further understanding of the subject.

Education and technology adoption theories have impacted on the construction of subjects delivered using Web 2.0 technologies. Subjects are designed to ensure that the learning activities and assessment tasks are aligned with the specified learning outcomes (Biggs 1996; Biggs & Tang 2007). In order to effectively design and develop a blended learning and teaching experience for students or a Web 2.0 augmented delivery, the human computer interface and effective use of emerging technologies must also be considered. Additional theoretical underpinnings are required during the design and implementation phases of curriculum development (Davis 1989; Nielsen 1994). Rather than the icon chosen for the graphical user interface and the associated action being evaluated together to ascertain a fit-for-purpose design decision, each component is often considered separately. A Design Science Research approach to curriculum development enables the use of the affordance concept which requires the use of both technology and learning theories to ensure attention is paid to the learning and delivery mechanisms.

2.4 Design Science Research in Information Systems

This research evaluates learning activities in the human domain and web technology in the technical domain, in higher education institutional context. The Information Systems discipline sits at the intersection between machine knowledge and human behaviour. Any investigation in this domain draws on the disciplines of natural science and social science to allow the integration of machine knowledge and human behaviour in the investigation (Gregor 2006). Information Systems theory is concerned with the use of artefacts in human-

machine systems. Different views on theory also depend to some degree on philosophical and disciplinary perspectives (Gregor 2006).

Philosophers of science, writing in the tradition of the physical or natural sciences see theory as providing explanations and predictions which are testable, whilst social science philosophers view theory as based on logical positivism and interpretive research. In general, the perspectives on theory describe theories as abstract entities that aim to describe, explain and enhance an understanding of the world, to provide predictions of what will happen in the future, or to give a basis for intervention and action (Gregor 2006). Theory helps to explain and simplify the operation of artefacts and events by identifying and describing the patterns found in our world. The theories in Information Systems are classified into four central goals and from the combination these goals, five types of theory were classified in Table2.3 (Gregor 2006).

Table2.3: The five types of theory in Information Systems (adapted from Gregor 2006)

No	Types of theory	Goal	Definition
1	Analysis	Describe phenomena, analysis of relationship among constructs, degree of generalisability in construct and relationships, and the boundaries within which relationship and observations hold.	Describe phenomena (what is) but there is no extension beyond analysis and description, no causal relationships are specified and no predictions are made.
2	Explanation	How, why and when things happened, varying views of causality and methods for argument – intended to promote greater understanding or insights by others into the phenomena of interest.	Describe phenomena (what is, how, why, when and where), provides explanation but does not aim to predict with any precision and no testable propositions.
3	Prediction	What will happen in the future if certain preconditions hold – degree of certainty in the prediction is only approximate or probabilistic.	Describe phenomena (what is and what will be), provide predictions, testable propositions are generated but there are no well-developed justificatory causal explanations.
	Prescription	A special case of prediction where the theory provides a description of the method or structure or both for the construction of an artefact (like a recipe).	
4	Explanation and prediction		Describe phenomena (what is, how, why, when, where and what will be), provides explanation and predictions, testable propositions and causal explanations are generated.
5	Design and action		Describe how to do something, provide explicit prescriptions (e.g., methods, techniques, principles of form and function) for constructing an artefact.

A Design Science Research approach was chosen to extend the explanation of the system's adoption and contribute to improvement in the system design. The system in question is the adoption of Elluminate, to facilitate learning and teaching in higher education. A Design Science approach demands that the impact of the adoption of each Elluminate affordance will be investigated with a view to improving the learning activities.

The popularity of the use of technology adoption theories such as TAM and DIM to predict adoption and diffusion within organisations is well recognised (Burke et al. 2002; Fisher 2010; Huang, Rauch & Liaw 2010; Hwang & Lockwood 2006; Lin 2008; Mitchell 2003; Peffers et al. 2007; Walsh 2007; Wang, Xia & Fang 2007). However, from an institutional learning perspective, technology adoption requires alignment of the specific organisational

and learning context for curriculum design and the use of appropriate affordances in learning activities. The use of a new technology to support interaction and communication during online learning activities challenges traditional methods of delivery for university teaching.

According to Hevner et al. (2004), Design Science Research is increasingly recognised as complementary to behavioural science research in the Information Systems domain. Behavioural science develops and verifies theories that explain or predict human or organizational behaviour while design science extends the boundaries of human and organisational capabilities by creating new and innovative artefacts (Venable 2006a). Both behavioural science and Design Science Research paradigms are fundamental to the Information Systems discipline, as they require investigation of the people, organisational and technology aspects within a context.

Behavioural science addresses research through the development and justification of theories that explain or predict phenomena related to an identified organisational need. Design Science Research addresses research through the building and evaluation of artefacts designed to meet an identified organisational need. The aim is to improve existing systems and processes with a view to improving business productivity and servicing. The goal of behavioural science research is truth which may or may not directly impact on the way the investigated business Information System operates while the goal of design science research is utility (effectiveness or value) (Hevner et al. 2004).

Design Science creates and evaluates artefacts intended to solve identified organisational problems. Further evaluation of a new artefact in a given organisational context affords the opportunity to apply empirical and qualitative methods. Artefacts are broadly defined as

constructs, models, methods or instantiations that can contribute to research knowledge (Hevner et al. 2004; March & Storey 2008). They are created to enable the representation, analysis, understanding and development of Information Systems within organisations. Table 2.4summarises the artefact definition and outputs in design science research.

Table 2.4: The artefact and output in Design Science Research (adapted from Hevner et al. 2004; March &Storey 2008; Vaishnavi & Kuechler 2008)

No	Artefact	Description
1	Constructs	The conceptual vocabulary of a domain - vocabulary, symbols and conceptualisations – enable communication and description of problems (phenomena), solution components, constraints and objectives
2	Models	A set of propositions or statements expressing relationships between constructs; abstractions and representations - use constructs to represent a problem and its solution space
3	Methods	A set of steps used to perform a task – how-to knowledge; algorithms, practices or guidelines that are used to search the solution space and enable the construction of instantiations
4	Instantiations	The operationalisation of constructs, models and methods; implemented and prototype - systems implemented within an organisation
5	Better theories	Artefact construction as analogous to experimental natural science

The constructs, models and methods are evaluated with respect to their ability to improve performance in the development and use of technologies embedded in Information Systems. Instantiations or implementations demonstrate the feasibility of utilising those information technology artefacts for a given task. The output of a research project where the method is underpinned by Design Science Research is an artefact that may be an instantiation, method, construct, or improved or emergent theories (Hevner et al 2004; March & Storey 2008; Vaishnavi & Kuechler 2008).

A Design Science Research contribution, according to March and Storey (2008), includes rigorous evaluation of Information Systems artefacts enabling the assessment of its utility; an articulation of the value added to the Information Systems knowledge base and to practice; and an explanation of the implications for Information Systems management and practice. Hevner et al (2004) mentioned that the contributions could be in the form of a design artefact

(the artefact itself); foundations (the creative development of a novel, appropriately evaluated artefact that extends and improves the existing foundations in the design science knowledge based); methodologies (the creative development and use of experimental, analytical, observational, testing or descriptive evaluation methods) or new evaluation metrics providing design science research contributions based on novelty, generality and significance of the designed artefact. A different perspective on the multiple outputs of Design Science Research is classified by the level of abstraction (Vaishnavi & Kuechler 2008). The abstraction is categorised into three levels:

- artefact as situated implementation;
- knowledge as operational principles; and
- emergent theory about embedded phenomena.

2.4.1 Guidelines for the Use of a Design Science Research Approach

In evaluation of developed artefacts, anti-positivistic epistemology is highly relevant in Design Science Research (IIvari & Venable 2009; Niehaves 2007). Interpretive methods are appropriate for naturalistic, in situ evaluation (Venable 2006a; Venable & Travis 1999). It is not necessarily evaluated by the researchers who originally designed the technology (vom Brocke, Simons & Schenk 2008). This research looks at the implementation stage of Elluminate affordance adoption and implementation by lecturers in the higher education learning and teaching environment.

This research is creating a process for change or improvement to the curriculum design construction process. In an organisation, top management allocate financial resources to the implementation of emergent technologies but there has to be a justification that evidences

improved products and services that are beneficial to the organisation (Sharma, Yetton & Zmud 2008). Since adoption and implementation benefit the organisation as a whole, staff are expected to be involved to use their operational functional knowledge to ensure success (Lies 2012).

It is very difficult to introduce change in organisations and there are instances where technology adoption fails (Lai & Ong 2010). They believe this is due to the readiness of the staff in the organisation to accept change by adopting an emerging technology.Socio-technical organisational systems that enable people at the operational level to initiate change is important to the successful change when implementing Information Systems (Richardson 2007; Bednar & Green 2011). Early adopters of web interactive multimedia affordances and associated devices provide a large pool of potential innovators. The requirement is for lecturers and students to use interactive and social networking affordances in the learning and teaching environment of the university rather than at home. In higher education organisations, change management in implementing emerging technologies is important in order to gain the benefit of improving learning and teaching (Lai & Ong 2010).

Action Research is research discussing change in an organisation (Lagsten 2011). Although there has been discussion about the similarities between Action Research and Design Science Research in terms of the research activities, there are still some differences (Attwell 2010). Action Research provides a new lens with which to explain phenomena whilst Design Science Research requires an artefact that contains an improvement to the current situation as an outcome. Design Science Research adds to Action Research as it is more than a research method; it is a research orientation (IIvari & Venable 2009). It is not bonded to any particular type of artefact, paradigm, method or technique (Levy & Hirschheim 2012).

Ilvari and Venable's (2009) Design Science Research model contains four components: Theory Building, Naturalistic Evaluation, Artificial Evaluation and Solution Technology Invention. Action Research is a possible method within Naturalistic Evaluation as it provides an opportunity to understand an existing reality. Design Science Research constructs new and innovative methods of operating within a business Information System. Artificial Evaluation which is evaluation of purely technical problems and solutions is not part of Action Research, as Artificial Evaluation refers to laboratory-based experiments. Action Research is exclusively interested in socio-technical systems, in a context in which humans are interacting. In Design Science Research, the problems and solutions included are technical and socio-technical, as reflected in the framework containing the Artificial Evaluation and Naturalistic Evaluation components. Design Science Research is chosen for this research as the aim is to produce an artefact which in this case is a guide for subject design which will improve the lecturers' provision of learning activities and assessments to meet learning outcomes, in a constructivist learning paradigm. Design is important before adopting emerging technology, as it is better to plan not to fail rather than fail to plan. In design, the ability to think critically and develop a sound plan are needed to assure technology adoption and implementation success (Richardson, Fairservice, Grob, Pelts, Smith & Tolson 2011).

There is some variation in the guidelines for Design Science Research in Information Systems. One set of guidelines by Hevner et al. (2004) has been widely cited. Hevner et al.'s (2004) seven guidelines for planning research using a Design Science approach require that attention be paid to:

- designing an artefact;
- problem identification and relevance;

- design the evaluation of the current situation;
- identification of the research contribution;
- ensuring a rigorous research approach to data collection and analysis;
- design the research initially as a search process; and
- communicate and disseminate the research outcomes.

Following this, Peffers et al. (2007) proposed a Design Science Research methodology that provided a model for presenting and evaluating Design Science Research in Information Systems. Peffers et al.' (2007) Design Science Research process has six steps:

- problem identification and motivation;
- definition of the objectives for a solution;
- design and development of an artefact;
- demonstration of the solution;
- evaluation of the solution or artefact; and
- communication of the research outcomes.

These guidelines for Design Science Research in Information Systems can be summarised in four main activities (Alturki, Gable& Bandara2011b):

- define the Design Science Research objective;
- determine the type of research: Design Science Research or Design Research or both;
- define the theme of the research: construction, evaluation or both; and
- define the design requirements, possibly through empirical work.

Design Science Research in Information Systems is categorised into one or both of two types: design science and design research (Alturki, Gable & Bandara 2011a). The study reported in this thesis falls within the design science type of Design Science Research. The artefact

created as an output could be used to guide the adoption of any software application containing the Elluminate affordances investigated in the research. Whilst the artefact to guide affordances choice is generic it is bound by the learning and teaching context. An adaptation of the Design Science Research steps used in this research is provided in Chapter 3 Methodology.

2.4.2 A Paucity of Design Science Research Applications

The analyses of Information Systems conference publications completed by Indulska and Recker (2008) indicated that Design Science appears to be a growing stream of research in Information Systems. They found Design Science Research to be widely accepted in the research domains of process, knowledge and information management. They also found that only a small percentage of the papers using Design Science Research discussed a concise and consistent implementation of the design science methodology suggested by Hevner et al. (2004). Currently, an increasing number of Information Systems researchers are conducting research dealing with Design Science Research. Oetzel and Spiekermann (2012) research is one of the few works that implemented Design Science to develop an artefact. They produced two artefacts: a problem structure and simple privacy management guideline.

A number of Ph.D theses examined Design Science Research in Information Systems. These include studies that:

- explore design theory in management Information Systems and medical informatics (Richardson 2006);
- use the design science paradigm as a guiding framework for developing a decision support mechanism in an influenza pandemic (Arora 2009);

- develop a model for a wireless networking protocol (Peacock 2012);
- create a web service repository to aid the elicitation of business software requirements (Delano 2011);
- propose a design framework for computer-mediated text-analysis systems grounded in systemic functional linguistic theory (Abbasi 2008);
- describe persuasive technologies for people with disabilities in the workforce development context and develop a persuasive system design framework model (Al-Buhairan 2012); and
- develop and refine approaches to the analysis of web forums to derive information that may explain and predict firm stock behaviour (Zimbra 2012).

However, none of these studies have implemented Venable's (2006a) Design Science Research framework to underpin the research method. This thesis applies Venable's (2006a) framework to contribute to the understanding of the value of the practice of using the framework.

This research is searching for best practice to underpin the guide for implementation in higher education learning and teaching spaces. Design Science Research concurs with utility theories in that its goal is to produce an artefact (Venable 2006b). Utility theories are the link between solution technologies and problem understanding. A utility theory links some concepts of technology to the domains of the problem they address (Venable 2006b). The solution technologies refer to the solution space and the problem understanding refers to the problem space (Venable 2006b). In this thesis, the solution space is the findings of the web interactive multimedia technology affordances based on the stakeholder analysis. The problem space is identified by analysing the data from stakeholders' interviews whereby they described and reflected on their experience of using Elluminate.

In this research, Design Science Research was found to provide a suitable means for exploring technology affordances and the learning organisational infrastructure. This approach is particularly useful in situations when affordances are being used and evaluated in a higher education context. This research involved the collection of qualitative data from several cases in the higher education sector. Design Science Research has enabled the researcher to look at broad issues, probe a theoretical issue, and develop guidelines as an artefact. The Design Science approach was used to evaluate the implementation of affordances in learning activities to achieve the desired learning outcomes in a university context.

2.5 Design Science Research Framework

Using a Design Science Research approach has been considered an innovative method to examine the organisational, technology and people perspectives of adoption. The approach enables a holistic Information Systems design and solution development focus. In this study of the adoption and implementation of Elluminate affordances in a higher education learning and teaching context the research approach contributes to design knowledge. Technology and learning theory play essential roles in explaining and resolving the problems of adopting and implementing emerging technologies in universities (Gosper et al. 2008; Gray et al. 2011). However, although improvements in learning in higher education institutions have often described links between learning theory and web technology, the links between particular affordances and learning have rarely been supported by empirical evidence. This study focuses on the use of Elluminate affordances in learning activities.

2.5.1 Design Science Research Model Components

The framework and context for Design Science Research consist of four main domains: Solution Technology Invention, Artificial Evaluation, Naturalistic Evaluation and Theory Building (IIvari & Venable 2009; Venable 2006).Solution Technology Invention refers to enhancement or creation of a method, product, system, practice or technique; designed to improve the current product or service (Venable2006a). Artificial Evaluation refers to computer simulations, role playing simulations, field experiments and laboratory experiments (Venable2006a).Naturalistic Evaluation refers to case studies, survey studies, field studies and action research (Venable2006a). Theory Building refers to utility theories or hypotheses, conceptual frameworks and problem theories (Venable 2006a). Multidisciplinary theories are required to evaluate the affordance use within a functional context.

Design Science Research broadens the contextual methodology for studying the adoption of technology in the learning context by underpinning it with Theory Building and from stakeholders' analysis and affordances implementation. There have been calls for more research to be conducted to meet the challenge of combining web technology and human activities within a complex system (Bader-Natal 2009; Rojas, Kirschenmann & Wolpers 2012). The logical extension of the combination of technology and human activities is that theoretically, the adoption of web technology must be influenced not only by individual traits, but also by contextual traits within which the web technology is used including the organisational infrastructural constraints determined by the particular learning context.

Design science extends the current practice of studying the adoption of technology in Information Systems by enabling the construction of a research model that has a Theory Building domain grounded throughout the whole research process. The conceptual framework

developed, guided the exploration of Elluminate affordance implementation in higher education institutions. Design Science Research addresses the adoption of emerging technology by investigating a contextually based implementation. Rigor is assured through the use of theories that validate the contextual function, in this case the learning design and the adoption of emergent technologically based affordances. This is shown in the evaluation of data within each domain.

Peiris, Armstrong & Venable (2011) used design science as the research paradigm based on the Design Science Research framework by Venable (2006a). The framework was used as the research process model. The research steps followed by Peiris, Armstrong & Venable's (2011) demonstrated an identifiable pattern:

- Theory Building- postulated the suitability and high-level design of ideas for designing a solution to a problem;
- Solution Technology Invention– enabled the development of three artefacts;
- Artificial Evaluation– dictated the use of focus groups to obtain the real adoption story and gathering of historical data).

In this example of a Design Science Research approach to method generation, Naturalistic Evaluation was omitted and stated as inappropriate given the nature of the problem and the difficulty in gaining access to opinions and beliefs, as the research related to nuclear weapon development the case in question. However, in this research, Naturalistic Evaluation was included and Artificial Evaluation was omitted as this research is not lab-based. Artificial Evaluation was not relevant due to the nature of the research, where stakeholders in a university learning environment are more open to be interviewed about learning practices.

2.5.2 Solution Technology Invention

In this research, the Solution Technology Invention domain focuses on using Elluminate affordances to deliver learning and teaching resources. The focus is on the technology referring to how it is used physically to complete the delivery of subject (the method of delivering a learning activity designed to augment student learning). Technology has long been associated with individual use and perceptions of ease-of-use and usefulness (Davis 1996). The embedded problem-solving approach drawn from soft systems considers people, organisations and technology (Ang & Slaughter 2001).

The technology, organisation and people framework traces its origin to Laudon and Laudon's (1998) perspective on using Information Systems effectively requiring an understanding of the technology, organisations and management, in context. Hillier and Vogel (2003) mentioned that the technology, organisation and people framework mirrors Checkland's (1981) soft systems model for the development of solutions to problems and Mitroff and Linstone (1993) insistence on the use of multiple perspectives to solve technology based problems. The technology, organisation and people framework could also be applied to systems analysis and design (Hillier & Vogel 2003).

There is now a need to examine Web 2.0 technology use to support collaboration and interaction between all students and lecturers. Web browsers are the dynamic and non-linear navigational interface for collaborative interactions and open access to information. Using the hyperlinks in web pages, stakeholders can navigate to other pages upon a whim. Web interactive multimedia technology affordances enable both interaction and collaboration

which creates a powerful virtual learning environment that can closely resemble face-to-face communication experiences.

Web interactive multimedia technology enables collaboration between peers and interaction similar to that available in a traditional classroom. In a blended learning environment, there is an opportunity to run traditional and new activities using technology at the same time (Stone 2009). There is a current growth of case study based research investigating how to operate in a blended environment and assessing the impacts on pedagogy. Current studies adding to the educational research describing blended environments include a:

- case study of technology affordance use in a blended environment (Watson, Mong & Harris 2010);
- study of a technology-based environment (Cavus & Kanbul 2010);
- study of blended learning using a range of methods which included a face-to-face approach e-learning (using Web-CT) and distance learning packs (Marino & Hayes 2012); and
- finding that learning quality on the web in a blended subject is enhanced by interaction (Heckman, Qing & Xue 2006).

In this thesis, Elluminate provides a number of Web 2.0 affordances including: interactive text or chat, audio conferencing or chat, video conferencing, polling, emoticons and an interactive screen-board. Elluminate facilitates stakeholders' communicating in real-time, using a personal computer, an internet connection and optional microphone and web-cam. The difference between web conferencing and video conferencing is the equipment, back-end infrastructures and cameras used in the setting. Web conferencing requires web browser and

an optional web-cam, whilst video conferencing requires special equipment and a camera in a specific physical location. Web conferencing is more convenient than video conferencing.

Stakeholders were interviewed to explain their use of Elluminate affordances in learning activities. Based on the stakeholders' experiences that fostered and hindered their actual use of the affordances, an analysis underpinned by the Design Science Research conceptual model was undertaken. The use of the Design Science Research in Information Systems approach fulfils the call for using an alternative approach to not only evaluate the implementation of emerging technologies but suggest improvements to adoption systems via a utility theory (Venable 2006b; Williams, Dwivedi, Lal & Schwarz 2009).

2.5.3 Elluminate – Web Interactive Multimedia Technology Affordances

Web affordances were initially dominated by text-based dissemination or transfer of information. The movement of information was generally in one direction, from the lecturer to a cohort of students. Information was designed to be transferred from one-to-many and not to engage in interactions with students. Web 2.0 applications have now become complex systems that support affordances that enable communication that includes audio, images, emoticons, screen-board interaction and video conferencing (Md Ali & Richardson 2011b).

Bader-Natal (2009) discussed the interaction choice for synchronous and asynchronous learning. Interaction changes according to the number of people involved. For example, the interaction between two people in a telephone conversation, changes to a different type of interaction when a third joins in the conversation. If twelve people are involved in a conference call the type of interaction changes again to support information flow. Bader-

Natal's (2009) study found that the size of student groups can be scaled for learning based on a virtual group paradigm. As in (physical) conversation between two people, conversation changes when more people get in. The number of students in a web session is not limited because the participants could be grouped into many groups according to the virtual group paradigm (Bader-Natal2009). This thesis illustrates the need for changing the mode of delivery for learning to accommodate the number of students in a web session.

Time is also important in the use of affordances in a web session. Reuben (2008) addressed the time issue by recommending the prioritising activity and interaction time commitment. Web 2.0 enables the sharing of information instead of the individuals spending time searching for the same thing over and over again (Stone 2009). Time is also related to download capacity, which is the server capability to download an amount of data in a specific time. Inability to download information due to technical infrastructural constraints was a major inhibitor to lecturer's adoption of Web 2.0 affordances to created blended learning environments. Download capacity was an issue for all stakeholders participating in web learning sessions (Deumert & Spratt 2005). The non-verbal cue is missing on the web session but is compensated for by the availability of emoticons, designed to convey feelings (Rojas, Kirschenmann & Wolpers 2012). Goodwin, Kennedy &Vetere (2010) studied the use of technology for informal learning and found that technology provided opportunities for similar interactions to physical face-to-face environments.

2.5.4 Naturalistic Evaluation

The Naturalistic Evaluation domain focuses on the opinions of stakeholders. The reasons for using affordances have to be associated with the context of using the affordance. The

explanation for why a particular affordance is chosen by a lecturer is associated with how the affordance is used. For example, a lecturer might choose to use the polling affordance to enable students to validate learning during a web lecture session where chat was disenabled. The focus of this research is why lecturer's chose a particular affordance to support a learning activity. Stakeholders were asked their opinion of the capacity of each Elluminate affordance to assist them in attaining the prescribed learning outcomes. The focus on stakeholders' perceptions aligns with the direction of the Information Systems research community that is broadening its focus towards stakeholder-oriented qualitative data collection methods (Iivari, Isomäki & Pekkola 2010). The research reported in this thesis used a qualitative case study for data collection. Soft systems in systems thinking and stakeholder theory support this research (Ang & Slaughter 2001).

2.5.5 Theory Building

The Theory Building domain focuses on the alignment Elluminate affordances used in learning activities and stakeholder perceptions of the achievement of intended learning outcomes (Biggs1996). The theory ensures design of effective curriculum and associated resources. Biggs's (1996) theory of constructive alignment highlights the importance of the subject design phase of affordance implementation. The potential of both the technology and learning strategies to incorporate constructivist initiatives in education led to this research.

Web interactive multimedia technology affordances are used in many organisations to support blended learning environments. A university provides a formal platform for learning and teaching activities, which are a major business function. Web technology can facilitate the production of graduate with 'work-ready' technology skills practiced as a component of the

learning and teaching environment, irrespective of discipline focus. Although universities have invested in web interactive multimedia technology, it is up to the lecturers and students to use it to support and enhance their learning. Lecturers choose whether to adopt the emerging technology for teaching in their subjects. When they do so, their students are exposed to the technology and explore it for their learning (Elgort 2005). The use of web interactive multimedia technology affordances in learning and teaching is relatively new as emerging technologies have rapidly evolved.

It is a challenge for a university to use web interactive multimedia technology affordances to facilitate and enhance students' learning, as effective implementation is dependent on a range of stakeholders' knowledge and understanding. By using web interactive multimedia technology, a university can enhance and support learning, as individuals can choose to continue formal learning at any stage of life. Attendance at traditional classes can be optional as alternative delivery methods are available. Learning at universities can be continuous or episodic depending on individual life stages.

2.5.6 Web Interactive Multimedia Technology In Learning

Web interactive multimedia technology affordances are used in physical teaching spaces and virtual learning domains. When students in a face-to-face classroom space are also equipped to interact with learning resources accessible virtually, (i.e. outside the traditional classroom boundaries) the environment is referred to as a blended learning space.

Wall & Ahmed's (2008) study investigated the capacity of simulation games presented in a blended environment to influence lifelong learning. Virtual or physical learning spaces and

various combinations that generate blended learning environments can be visualised with synchronous or asynchronous learning opportunities in a matrix (Fisher 2010). Mitchell (2003) created a blended learning matrix that illustrated the extremes: face-to-face learning in a traditional physical learning space and virtual web-based learning. Combinations of virtual and physical web-based learning that were time dependent or independent were also displayed in the matrix. Mitchell's (2003) four quadrants includefirst quadrant - local (physical), synchronous, conducted in a face-to-face meeting place; second quadrant - local (physical), asynchronous and site-specific e.g. signage, exhibitions and installations; third quadrant - remote (virtual), synchronous, participate in a tele-conference or video-conference, instant text messaging or shared cyber links; fourth quadrant - remote (virtual), asynchronous and facilitates web information access, such as, internet, web and "Google it".

Constructive alignment principles can be used to design a personal learning environment or a class (Biggs 1996, 2002; Biggs & Tang 2007). A personal learning environment is a space where the learner uses several technologies to learn and further understand a subject or seek knowledge. Attwell (2007) used the term 'Personal Learning Environment' to refer to students using Web 2.0 technologies in a non-classroom based space constructing their own learning. Personal Learning Environment does not require an individual to use a particular application but refers to individual choice from the plethora of available tools. Many of the tools are based on Web 2.0 technologies. While Attwell (2007) looked at a learner's personal environment, this research looks at Elluminateas a platform for a lecturer to interact with students attending class in their own homes. There is a need to study the pedagogical impact of Web 2.0 use in universities to boost learning (Grosseck 2009).

The number of students in a class has the potential to affect how much is learned (Cervinschi & Butucea 2010). Web interactive multimedia technology affordances enable interaction between students and lecturers (Cervinschi & Butucea 2010). With a small number of students, more activities are feasible than with a large number of students. The number of possible interactions for each student also increases therefore improving potential learning. There is a need to have different approaches according to the number of students in a group, particularly when using web interactive multimedia technology affordances.

Web interactive multimedia technology affordances can provide opportunities for new ways to improve the quality of learning, by using formal and informal assessment during the processes of learning and knowledge development (Attwell 2010). Student-moderated discussion and small groups are conducive for interaction (Chou 2002). The more the interactions, the more beneficial for student experience development and community building (Chou 2002). Web 2.0 provides a platform for collaboration by permitting interaction. Interaction promotes creativity, collaboration and changing of views (Lomas, Burke & Page 2008).

If effectively implemented, web interactive multimedia technology affordances can enhance students' learning experiences and increase learners' understanding and collaboration. Studies evaluating educational uses of Web 2.0 affordances are limited. Empirical research is needed in order to compile evidence about the use of web interactive multimedia technology affordances in the educational context.

2.5.7 Development of the Research Conceptual Framework

A review of theory and research on technology adoption and diffusion, as well as, learning led to the development of a research conceptual model underpinned by Design Science Research in Information Systems. The research conceptual model enabled the use of Biggs's (1996, 2002) and Biggs and Tang's (2007) theory of constructional alignment to ascertain the potential effectiveness of designed learning resources and activities; and the use of the technology adoption model (Davis1989) to look at the perspectives and practices of early adopters of Elluminate. Organisational infrastructural constraints to adoption were also considered in view of the impact on Web 2.0 affordance adoption in the higher education context.

This study developed a research model based on the Design Science Research approach and on the literature related to technology adoption and constructivist learning. This was different from the approaches of most related studies, which have focused on either innovation characteristics or higher education learning, but not on both. Using Elluminate as an exemplar of a web interactive multimedia technology in this study has filled a theoretical gap by developing a research model and using it to define and describe the data collection and analysis. The conceptual model for the study is underpinned by a system of concepts, assumptions, expectations, beliefs, and theories that support and informs the research. The incorporation of the soft systems components were a key component of the qualitative research design (Myers2009). Aconceptual model was developed and tested iteratively throughout the research (Ang & Slaughter 2001).

The three domains in the Design Science Research framework, which provided the conceptual model for this research, are Solution Technology Invention, Naturalistic Evaluation and Theory Building. These domains act as a map that needs to be taken into account in exploring web interactive multimedia technology affordances used in higher education (Figure 2.2).

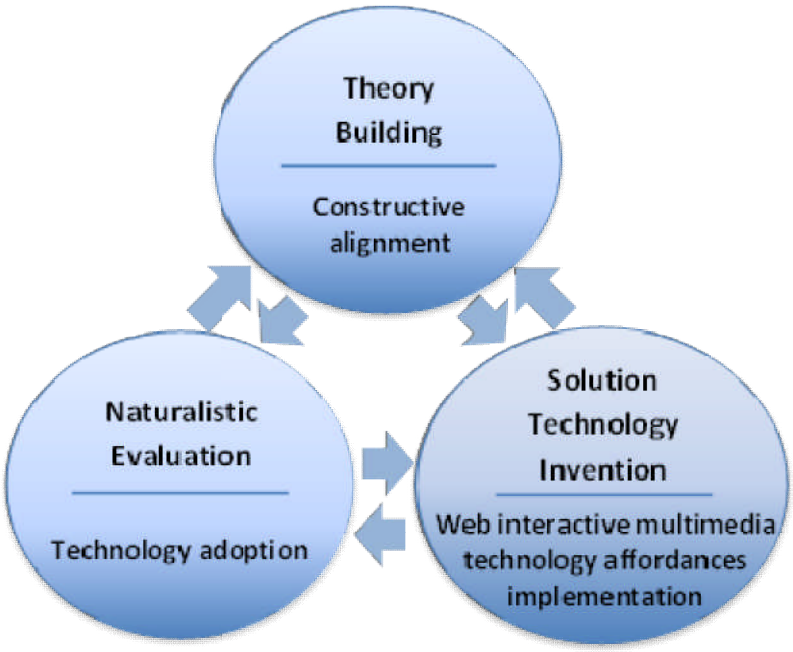

Figure 2.2: Research conceptual model (adapted fromVenable 2006a)

2.6 Summary

This chapter developed a research model to examine the use of technology in learning context at universities. Web interactive multimedia technology affordances enable the stakeholder to use it according to their practicality to achieve the intended learning objective. Web interactive multimedia technology is implemented in higher education to improve learning. A lecturer has the choice to adapt it. The issue in adoption is explored. The use of emerging technology affordances in learning is examined. To evaluate this, Ellumminate implementation is investigated through Design Science Research in Information System. The

Design Science Research framework (Venable 2006a) underpins the research conceptual model. Using this research conceptual model, the research plan was to explore the approaches in the adoption of Elluminate affordances in university learning environment and to identify the affordances used. The next chapter discusses the methodology used in this research where the implementation of Elluminate was evaluated by integrating technology theory and learning theory through a Design Science Research approach.

3 Methodology

This chapter outlines the methodological and analytical approach taken in this study. A Design Science Research approach was chosen to extend Davis' (1989) Technology Adoption Model and Rogers' (2003) Diffusion of Innovation theory (Rogers 2003). The Design Science Research approach contributes to the understanding of web interactive multimedia technology implementation in the higher education context. The approach allows the researcher to examine issues concerned with how Elluminate affordances are used in learning activities. The main issue of the problem is the need for supporting decision making in implementing web interactive multimedia technology affordances in university subjects. The research methodology was based on a Design Science Research approach in Information Systems and a case study methodology using qualitative data collection and analysis was used in this study (Venable 2006a). The justification of such methods is discussed in this chapter (Yin 2009).

This research is exploratory in nature with the aim of generating well formulated utility theories. The contextual analysis builds upon these theories which lead to understanding and confirmation of adoption issues. The results of the analysis provide a conceptual guide as an outcome of this research. A qualitative approach was used to explore the research problems through the point of view of stakeholders, describing their views of Elluminate use explicitly. The exploration of the use of Elluminate affordances, their constraints, adoption and alignment, demanded a qualitative research method. This Design Science Research approach supported the investigation of little known and complex problems in their natural settings (Myers 2009).

The approach drives the data collection and analysis underpinned by several theories and inclusive of stakeholders' perspectives of the impact of Elluminate on the quality of their teaching. This chapter is organised into seven main sections describing:

- Section 3.1 – the Design Science Research approach
- Section 3.2 – the case study approach to data collection
- Section 3.3 – an interpretive research approach to data analysis
- Section 3.4 – qualitative data
- Section 3.5 – the research design which describes the participants, interviews and analysis
- Section 3.6 – the limitations of the study
- Section 3.7 – the steps taken to obtain ethics approval
- Section 3.8 – summary of this chapter

3.1 Design Science Research Approach

A Design Science Research approach was chosen in order to develop a comprehensive understanding of the various complex approaches to using Elluminate affordances in blended learning environments. Case studies chosen for inclusion in the study were early adopters implementing Elluminate to support subject delivery. The Design Science Research framework described in Chapter 2was adopted to create the research conceptual model for this research (IIvari & Venable 2009). All planned data collection and analysis activities were underpinned by the research conceptual model. The Design Science Research approach taken is more iterative than linear. The Solution Technology Invention, Naturalistic Evaluation and Theory Building domains were used to organise the evaluation of the case studies.

The Design Science Research framework provides a more holistic data collection and analysis approach than Technology Adoption Model and Diffusion of Innovation Model. The approach used in thesis ensures that the opinion of stakeholders is considered, as well as, the organisational and technological imperatives and constraints to adoption. A Design Science Research approach drives the consideration of context on adoption apart from a purely technological functionality perspective. Stakeholders' perspectives in a natural setting are considered whilst the research design is grounded with theory.

Evaluation commences with a description of each case study's contextual influences on the design and delivery of learning activities and assessments. Interviews were conducted with stakeholders and the transcripts were analysed using the stipulated Design Science framework domains. Within each domain, the analysis and review process was logical and iterative. The qualitative data collection and analysis method was based on semi-structure interviews that focused on learning and teaching. The difficulties and advantages of using Elluminate to learn and teach were described from stakeholders' perspectives. The analysis was fundamentally interpretive and relied on the emergence of themes.

3.1.1 Elluminate Affordances Use from an Information Systems Perspective

This thesis takes an Information Systems perspective which means that the learning and teaching context of each case study is a dynamic system involving not only the technological artefact (Elluminate) but also people (Beynon-Davies 2010).

Studies describing the impact of Web 2.0 technologies on learning and teaching have been attracting the interest of many Information Systems researchers in recent years. However, the

use of a Design Science Research approach to investigate technology implementation is still in its infancy (Peffers et al. 2007). This thesis aims to contribute to this emerging research endeavour by contributing to the Information Systems Design Science Research literature by operationalising Venable's (2006a) Design Science Research framework. Information Systems researchers have to constantly keep pace with the development and diffusion of information and communications technology and its diverse applications in the personal and professional areas of our lives (Howard, Anderson, Busch & Nafus 2009). The Design Science Research framework improves the theoretical agenda of the Information Systems field by guiding the research on technology with Theory Building, Solution Technology Invention, Naturalistic Evaluation and Artificial Evaluation. Research outcomes are required to deliver an improvement to current practice evidenced by a service or product artefact (Hevner et al. 2004).

Davis (1989) Technology Acceptance Model and Rogers (2003) Diffusion of Innovation Model are used to predict the adoption of the technology or Information Systems by an individual or an organisation. Davis (1989) Technology Acceptance Model predicts technology adoption based on research that describes stakeholders' or end-users' perceptions of 'ease-of-use' and 'usefulness'. The data collection method used to evaluate these factors is a survey that provides quantitative data as an outcome (Davis 1989). The results of the survey predict successful adoption of an Information System in an organisation. The Diffusion of Innovation Model is also used to predict the adoption of emerging technologies by locating the current use of a technology in an organisation at a specified stage. Rogers (2003) described adoption patterns and provided an explanatory nomenclature of relevant stages. Early adopters typically start to use a new Information System when it is introduced in the market or to the organisation where they work as they can perceive the technology as useful

of to their work (Baird, Furukawa & Raghu 2012; Mugwanya, Marsden & Boateng 2011). This thesis also includes discussion on whether early adopters fit into Postman's (1992) descriptive category of users, where the technology is related to deification as the users use the technology without thinking about the purpose and effect on life.

Most research looking at the adoption of emerging technologies for organizational productivity improvements has been undertaken during the pre-implementation phase of technology adoption, using quantitative methodology (Baskerville & Myers 2009; Chiasson & Davidson 2005; Lin, Fofanah & Liang 2011; Polančič, Heričko & Rozman 2010; Ransbotham, Mitra & Ramsey 2012). Little research has been undertaken using qualitative research to understand post-adoption implementation or emerging technologies in the higher education learning and teaching context (Nemutanzhela & Iyamu 2011). This research investigates post-adoption of Elluminate implementation, using a qualitative research approach.

3.1.2 Design Science Research Model – Solution Technology Invention, Theory Building and Naturalistic Evaluation

The Design Science Research model combined with stakeholder analysis enables the evaluation to look at individual contexts using Solution Technology Invention and Naturalistic Evaluation domains (Venable 2006a). The stakeholders in this research are academic developers, lecturers and students. Academic developers were typically involved in implementing Elluminate in higher education institutions, whilst lecturers implemented Elluminate in subjects taught. Investigation of adoption issues was designed to include the 'usefulness' and 'ease-of-use' from the individual perspectives to inform the curriculum subject design decision-making process.

The research conceptual model used for this study consists of three domains which are Theory Building, Solution Technology Invention and Naturalistic Evaluation domains (Table 3.1).

Table 3.1: A concise conceptual model

Conceptual model	Focus	Question
Solution Technology Invention	Technology focus	How is Elluminate used in learning activities?
Naturalistic Evaluation	Stakeholder (people) focus	Why Elluminate?
Theory Building	Learning focus	Why is Elluminate used in learning activities?

Theory Building provides the lens to analyse stakeholders' reasons for technology adoption and to evaluate business functionality without technology. Subjects included as case studies were evaluated to ensure effective constructional alignment of learning outcomes. Activities and assessments were scheduled irrespective of technology use (Biggs 1996; Biggs & Tang 2007). Learning and teaching is the primary business function in this research. Solution Technology Invention looks at how each stakeholder chooses to use Elluminate affordances, the problems faced and the strategies used to overcome technological and pedagogical constraints. Naturalistic Evaluation looks at the stakeholders' perceptions and informs the Theory Building and Solution Technology Invention domains.

3.1.3 The Research Process

This approach is not purely technology focused but also considers the impact of people and the business function on technology implementation. The Design Science Research model also enables the use of soft systems tools to organise and analyse the qualitative data. Systems thinking looks at real environments that are not laboratory-based or artificial.

This research looks at the components of Elluminate affordances suitable for the learning and teaching. The technology has affordances that provide a medium for stakeholders to use in their work. The stakeholders' perspectives informed the researchers' understanding of strategies and practices that ensure the technology is used to meet the objectives. This research looks at the affordances that would be useful for a particular learning and teaching activity.

Finding an adequate grounding in methodology for this research was difficult, as the goals of this research incorporate elements of mainstream management, education and Information Systems research. The outcome of this research is not intended to be just a description of Elluminate affordances implemented in university contexts, that will improve understanding of the local environment. A problem-solution finding approach was undertaken to ensure a systems artefact was generated as an outcome of the research, to offer guidance to stakeholders and as a consequence improve practice (Hevner et al. 2004).

The Design Science approach ensures the construction of an artefact whereby educators and Information Systems specialists can be given some form of guidance when choosing web interactive multimedia technology affordances to deliver learning activities. The artefact provided can provide the foundation for how web interactive multimedia technology affordances can be best used in universities (Venable 2006a).

This research process following Design Science Research in Information Systems is summarised in Table 3.2. In defining the Design Science Research objectives, the scope of the research was identified based on the purpose of the research. The purpose of the research was to understand Elluminate affordance use in learning and assessment activities and to create a

guidance artefact to be used during the subject delivery design phase. The research required a theoretically based conceptual framework to drive the collection of data during stakeholder interviews and from subject guide documents, for each case study. Findings were extracted and synthesised, inductively from the data and deductively from the research conceptual model. Conclusions underpinned the guidelines for the web interactive multimedia technology affordances implementations in higher education were drawn.

Table 3.2: The summary of this research process (adapted from Alturki, Gable & Bandara 2011a)

Research Process	Explanation
Define Design Science Research objective	The scope of the research was identified based on the purpose of the research.
Determine the type of research: Design Science Research or design research or both	The type of this research is Design Science Research but the outcome is an artefact that could be used as a guide in the design stage of a subject for learning.
Define the theme of the research: construction, evaluation or both	The theme of this research consists of rigorous evaluation based on the Design Science Research framework.
Empirical work	Design a theoretically based conceptual framework. Search for and appraise the evidence. Collect data from interviews, subject guide documents and subject assignments documents. Extract and synthesise findings. Analyse data inductively and deductively from the research conceptual model. Draw conclusions and make recommendations which become the artefact as an outcome of this research.

The Research Method

In Design Science Research, evaluation of developed artefacts, anti-positivistic epistemology is highly relevant (IIvari & Venable 2009; Niehaves 2007). This research is designed to investigate systems for implementation of Elluminate affordances in higher education blended classrooms. An interpretive method is used to evaluate the Elluminate implementations, *in situ* (Venable 2006a; Venable & Travis 1999). According to Ilvari and Venable (2009), an interview research method to collect qualitative date to complete the evaluation phase is appropriate. The method is justified when the research is attempting to understand

organisational or individual appropriation and usage of technology in real life. The Evaluation of the impact of an emerging technology does not need to be completed by the researchers who originally designed the technology or implementation (vomBrocke, Simons & Schenk 2008). The Design Science Research approach is suitable to evaluate Elluminate, affordance implementations, designed for learning and teaching (Venable 2006a). Unlike Action Research where the outcome is a description of an alternative perspective of phenomena, Design Science Research demands an artefact that will impact on or change the current situation (IIvari & Venable 2009). Evaluation includes the integration of the artefact within the technical infrastructure of the environment. The evaluation of designed artefacts typically uses methodologies in the knowledge base as summarised in Table 3.3(Hevner et al. 2004). This research used case study as the methodology to observe the Elluminate implementation systems artefacts in depth.

Table 3.3: Design evaluation methods (Hevner et al. 2004)

Category	Methodology
Observational	Case study – study artefact in depth
	Field study – monitor use of artefact
Analytical	Static analysis – examine structure for static qualities e.g. complexity
	Architecture analysis – study fit into technical architecture
	Optimisation – demonstrate optimal properties
	Dynamic analysis – study for dynamic qualities e.g. performance
Experimental	Controlled experiment – e.g., usability
	Simulation – execute with artificial data
Testing	Functional (black box) testing – execute interfaces to discover failures and identify defects
	Structural (white box) testing – perform coverage testing in the implementation
Descriptive	Informed argument – build a convincing argument for the artefact's utility
	Scenarios – to demonstrate utility

3.2 Case study

Case study research is an essential form of inquiry (Morse & Richards 2002). The method is appropriate when researchers are forced by circumstances to define research topics broadly.

Typically case study research investigates contextual conditions and relies on multiple sources of evidence (Yin 2009). The case study method provides a good understanding of Elluminate used for learning and teaching in higher education, by looking at the way the emerging technology is used from stakeholders' perspectives. Yin (2009) stated that case studies are indeed analytically generalisable to theory. This study also takes on the interpretivist view. Walsham (2006) claimed that interpretive case studies can be generalised through the development of concepts, generation and refinement of theory. This research also supports the argument that case studies may also be used for testing and disconfirming theory (Miles & Huberman 1994).

As 'no research method is perfect', the case study method is found to be an appropriate fit for this research (Myers 2009, p. 255). It can be used to interpret data in a context in order to maximise the possibility to analytically generalise (Yin 2009). The number of participants available for data collection was limited since this technology was not widely adopted by lecturers at the time of the study.

3.3 Interpretive Research

The choice of the case study method could be independent of the underlying philosophical position. The three philosophical positions considered were positivist, interpretive and critical (Myers 2009). This research used the interpretive philosophical position. The research focused on the meaning to stakeholders of using Elluminate affordances in the higher education. The research was not based on a positivist position as it was not designed to test a theory. The research was also not based on a critical philosophical assumption because the

researcher did not have a distinct paradigm in setting an agenda or challenge prevailing beliefs, values and assumptions.

3.4 Qualitative Research

This research is qualitative in orientation, exploratory in approach and interpretive in nature. Qualitative research, as represented by a range of diverse mini-cases, is most suitable for capturing the contextual richness and complexities of the investigated system. Creswell (2009) talked about qualitative research as a means for exploring and understanding the meaning individuals or groups give to a social or human problem. The research design aims to follow up on 'emerging questions and procedures, data analysis inductively building from particular to general themes, and the researcher making interpretations of the meaning of the data […] Qualitative research methods are designed to help researchers understand people and what they say and do […] understand the social and cultural contexts within which people live'(Myers 2009, p. 5).

The research in this thesis used a qualitative approach while much other research in the general area has used a quantitative approach. This research examined the perspectives of three groups of stakeholders, not just students. Some studies have taken students' grades or performance as the learning outcome. This research did not look at students' performance or students' satisfaction but instead considered the perspectives of all the stakeholders on knowledge or understanding gained. This research included an inductive process where categories emerged from the collected data. Based on the research conceptual model, the transcripts of interviews were analysed using thematic analysis in each subject case.

Categories emerged for each domain in the research conceptual model. Following this, the stakeholder analysis was based on data from the case studies.

The integrity of qualitative research is discussed according to the two principles of methodological purposiveness and methodological congruence (Morse & Richards 2002). The first principle, methodological purposiveness, refers to the particular research purpose and questions that lead to particular data sources and analysis strategies. This research demonstrates the characteristics of methodological purposiveness as it has very practical goals. The chosen interpretive research using case studies and qualitative data collection provides the opportunity for a holistic approach necessitated by the blended learning and teaching environment (Bliuc, Goodyear & Ellis 2007). Working qualitatively means working with complex unstructured data to derive new understandings (Morse & Richards 2002).

The practical problems that require a qualitative methodology might be an unanticipated problem area in the classroom, that the experts seem unable to understand, or an area in which a pattern or behaviour is statistically clear but researchers can only guess the reason for it. The researcher needs stakeholders to explain their behaviour (Morse & Richards 2002). This research examines the complexities of stakeholders' implementations of Elluminate affordances in learning activities. This research is not simply describing a situation but deeply analysing it to produce the outcome of an artefact to guide subject design.

The second principle, methodological congruence, refers to the way a researcher thinks or asks what, where and how questions to develop a solution that integrates discovered components. This research entails congruent ways of thinking and demonstrates an alignment between the research problem or question and the method or manner in which data is

managed (Morse & Richards 2002). Data sources and analysis methods are not predetermined and there is some flexibility once a particular path has been chosen. The Information Systems case studies, in this research, were used as part of an iterative process of data collection and analysis (Walsham 2006).

3.5 Research Design

This research employs a variety of data collection methods in order to obtain a detailed description of Elluminate affordance use in higher education. The data collection methods include interviews, observation and document analysis. The research processes occurred in three phases: contextual study, empirical investigation using Design Science Research, and findings where an artefact was developed as an outcome. In Phase 1, the contextual study started with a review of the literature to generate a research framework and study approach. In Phase 2, Design Science Research, technology theory and learning theory guided the data collection using semi-structured interviews. Content analysis was also used to align case study learning objectives, activities and assessments (Biggs 1996; Biggs & Tang 2007). In Phase 3, an artefact to guide subject design in using web interactive multimedia technology affordances in learning activities was developed. The research processes were conducted in an iterative manner. The research design is summarised in a workflow diagram in Figure 3.1.

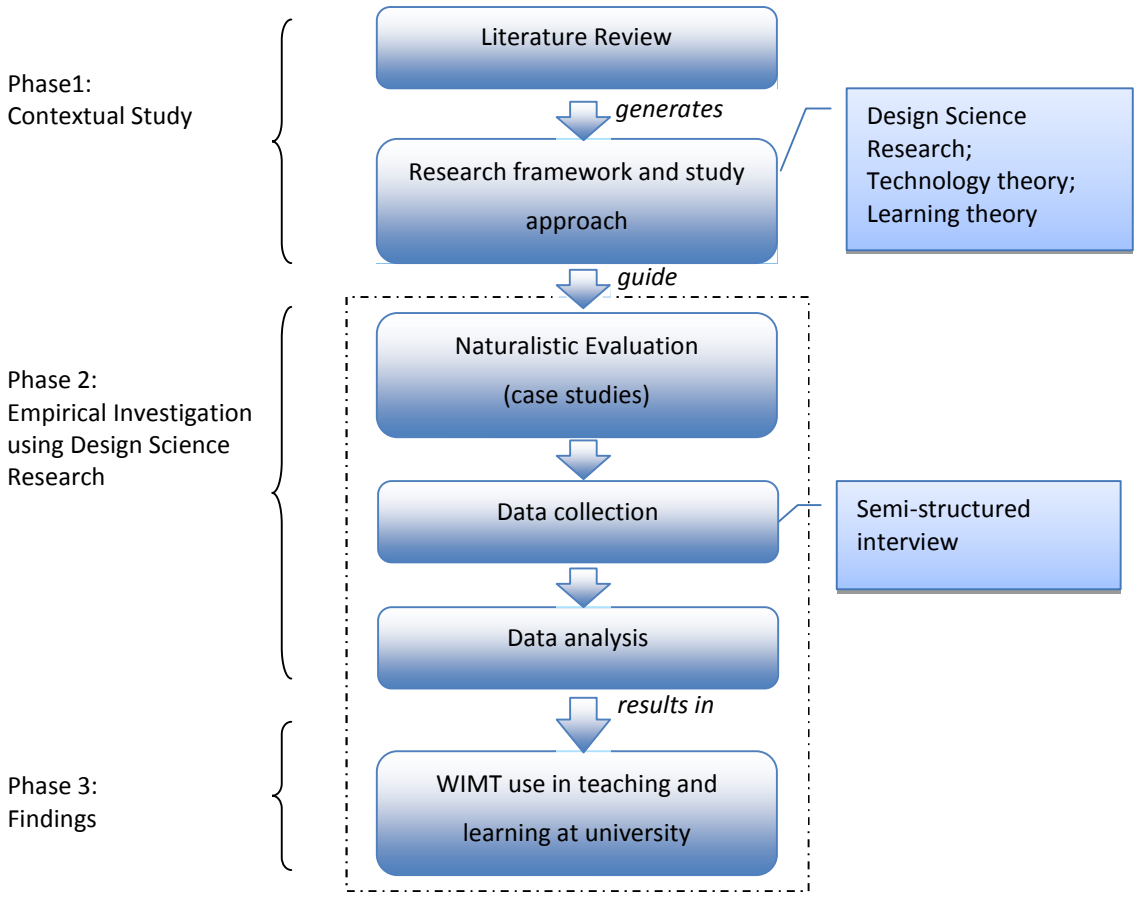

Figure 3.1: Research design (adapted from Creswell 2009; Ilvari& Venable 2009; Myers 2009; Venable 2006a; Yin 2009)

3.5.1 Participants

Initially, two main groups of stakeholders were deemed important, the lecturers and students. Later, a third group was included. Thus, the three main stakeholders identified were academic developers, lecturers and students. There were three academic developers, nine lecturers and four students who participated in this study. All of the participants used Elluminate affordances in university learning and teaching environments from three higher education institutions. The participants were initially contacted by telephone or e-mail to determine their willingness to participant in the project. With their consent, the interviews were conducted at

an agreed venue to explore the way Elluminate was used in their teaching and learning activities.

Table 3.4 shows the codes assigned to each stakeholder that were used in the analysis, their stakeholder categories and the number of times an interview was conducted with each of the interviewees.

Table 3.4: The stakeholders' categorisation and reference

No.	Interviewee	Stakeholder Category	No. of times interviewed
1	AD1	Academic Developer	1
2	L1	Lecturer	1
3	L2	Lecturer	1
4	L3	Lecturer	1
5	AD2	Academic Developer	1
6	L4	Lecturer	2
7	L5	Lecturer	1
8	L6	Lecturer	1
9	L7	Lecturer	2
10	L8	Lecturer	1
11	S1	Student	1
12	S2	Student	1
13	S3	Student	1
14	S4	Student	1
15	L9	Lecturer	1
16	AD3	Academic Developer	1

There were two participants, L6 and L7, that contacted the researcher and volunteered to have another meeting to demonstrate how Elluminate was used in teaching and learning activities with their students.

3.5.2 Interviews

This section describes the process of data collection and analysis relating to the semi-structured interviews with academic developers, lecturers and students. The process of data collection and analysis was conducted iteratively in accordance to the interpretive research tradition (Walsham 2006). Coding of interview transcripts was conducted line by line.

Themes emerged gradually for categorisation, and were then examined more deeply. The analysis was both deductive and inductive. Data were grouped into categories where themes emerged inductively in each domain of the conceptual model.

A semi-structured interview technique was chosen to allow the researcher to adapt questioning to the respondent's understanding of the topic under discussion. Open-ended questions allowed the researcher to gain insight into the opinions and values of the interviewee and permitted unanticipated information to emerge. At the same time, a semi-structured approach ensured that key topic areas were discussed with each interviewee. Thus each interview covered the broad topic areas depicted in Figure 3.2.

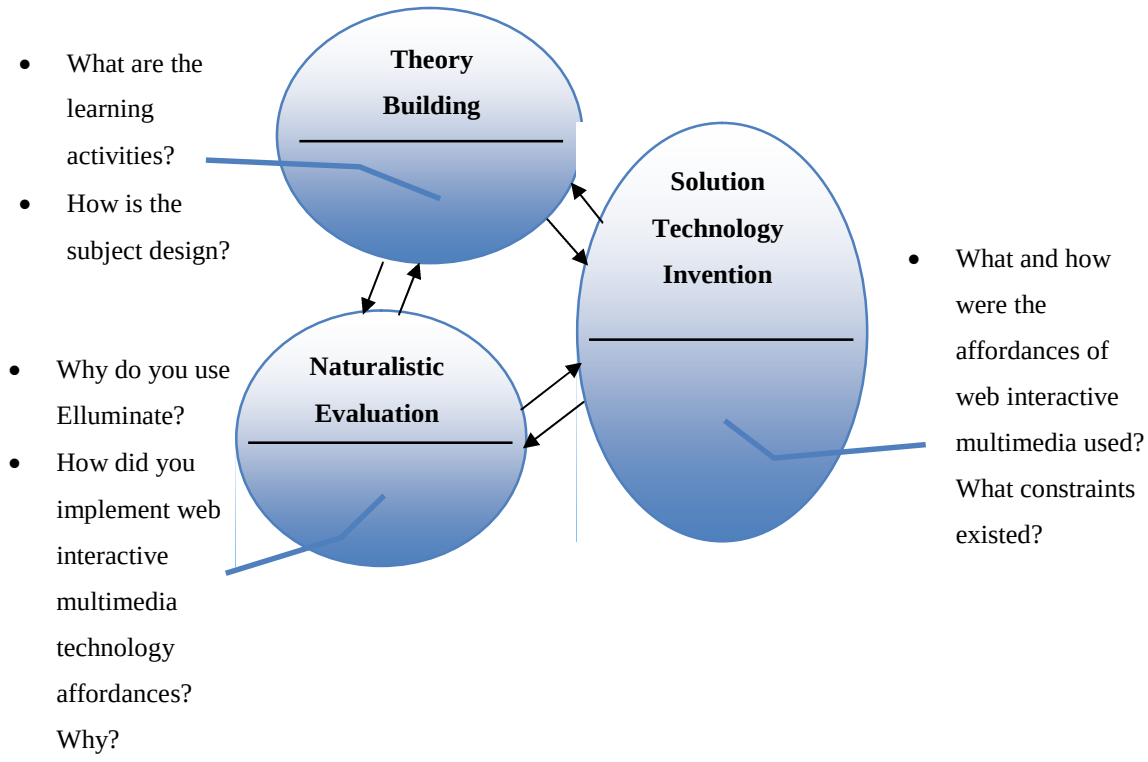

Figure 3.2: Interview broad topic areas based on the research conceptual model

These topic areas were introduced into the interview either as the issue emerged in dialogue or when the participant had ended their commentary on a topic. Questions were not fixed so that the researcher could probe and clarify responses in relation to the dimensions of the topic. The interviews ranged in duration from 30 minutes to 60 minutes. All the interviews were digitally recorded and transcribed by the researcher.

The interviews are not merely recordings (Kvale & Brinkmann 2009). By interviewing the stakeholders, a good understanding of the project goals and learning practices was obtained. Research interviewing is a craft, like a drama set, where the quality of the interview knowledge rests upon the skills and the personal judgement of the interviewer craftsman (Kvale & Brinkmann 2009; Myers & Newman 2007). Interviewing can be viewed as a knowledge producing activity and as a social practice (Kvale & Brinkmann 2009). The interviews generally began with an open-ended request for the participant to talk about their experience of using Elluminate affordances during web sessions and to reflect on their approach to the technology.

In line with a semi-structured approach, the themes the participants discussed were in no particular sequence. If a specific topic was not discussed spontaneously, participants were prompted to address it. When it was necessary to investigate the issues raised by the participants in greater depth, more probing questions were used. Towards the end of every interview, each participant was afforded the opportunity to add anything to the discussion and was given the option for further contact if necessary. In fact, follow-up interviews were undertaken for two of the lecturers and one academic developer.

Throughout the process of interviewing, a reflective research journal and an interview log were kept. The journal was used to record, on a day-to-day basis, notes and the researcher's experiences and reflections on the study. The notes were written during and directly after the interviews. Time was allocated to reflect on the interview and record notes soon after each interview. The notes recorded important points of the interview, personal impressions of how the interview went and preliminary interpretations of the data. The interview log recorded the date, day, time, venue and duration of the interview and the participant's contact details and designation.

3.5.3 Observation

Observation was also conducted in this study where the researcher observed some recorded sessions of the classes conducted using Elluminate affordances. Some students, participating in a class where Elluminate was used, agreed to volunteer as participants and were interviewed. One of the students continued the interview through e-mail. The observation provided more detail on the natural settings of the learning activities happening via Elluminate.

3.5.4 Document Analysis

Document analysis was also performed in order to describe the implementation of Elluminate affordances. In this study, subject guides are the documents that contain teaching schedules and activities. The information allowed the researcher to evidence constructional alignment of learning objectives, activities and assessments (Biggs 1996; Biggs & Tang 2007).

3.5.5 Thematic Analysis

The data from the interviews was analysed using thematic analysis. Thematic analysis provides a flexible and useful research tool which can potentially provide a rich, detailed and complex account of data. It involves a process of deductive and inductive coding. In this study, the thematic analysis approach used is theory driven and data driven (Boyatzis 1998). The steps involved in building themes are categorising, conceptualising and abstracting (Morse & Richards 2002). All the texts (substantive understandings, interview transcripts, field and analytical notes) were repeatedly engaged in the interpretive process. This took the form of reading the interview transcripts and noting all significant content relevant to the web interactive multimedia technology affordances used in learning activities. These codes were developed into themes as the analysis continued and as further evidence emerged that supported their continued presence in the data. The researcher also returned to the original digital recordings to check pauses and tone of voice, and to clarify sections of the text-as-data. The purpose of this was to maintain a close link with the interview data during the analytical process.

Data analysis started with the data collected from the interviews to define the affordances of a web interactive multimedia technology. Similar codes were then clustered into families of codes for a higher abstract level of analysis. Then the meaningful phrases were extracted from a subset of interview data and categorised into the initial themes from the research conceptual model that covered Solution Technology Invention, Naturalistic Evaluation and Theory Building domains, as depicted in Figure 3.3. The web interactive multimedia technology affordances and the constraints were analysed in the Solution Technology Invention domain. The stakeholder's feelings when using Elluminate affordances and their approach to implementing web interactive multimedia technology affordances in web classes were

analysed in the Naturalistic Evaluation domain. The implementation, following Biggs' (1996) constructive alignment theory in subject design, was analysed in the Theory Building domain.

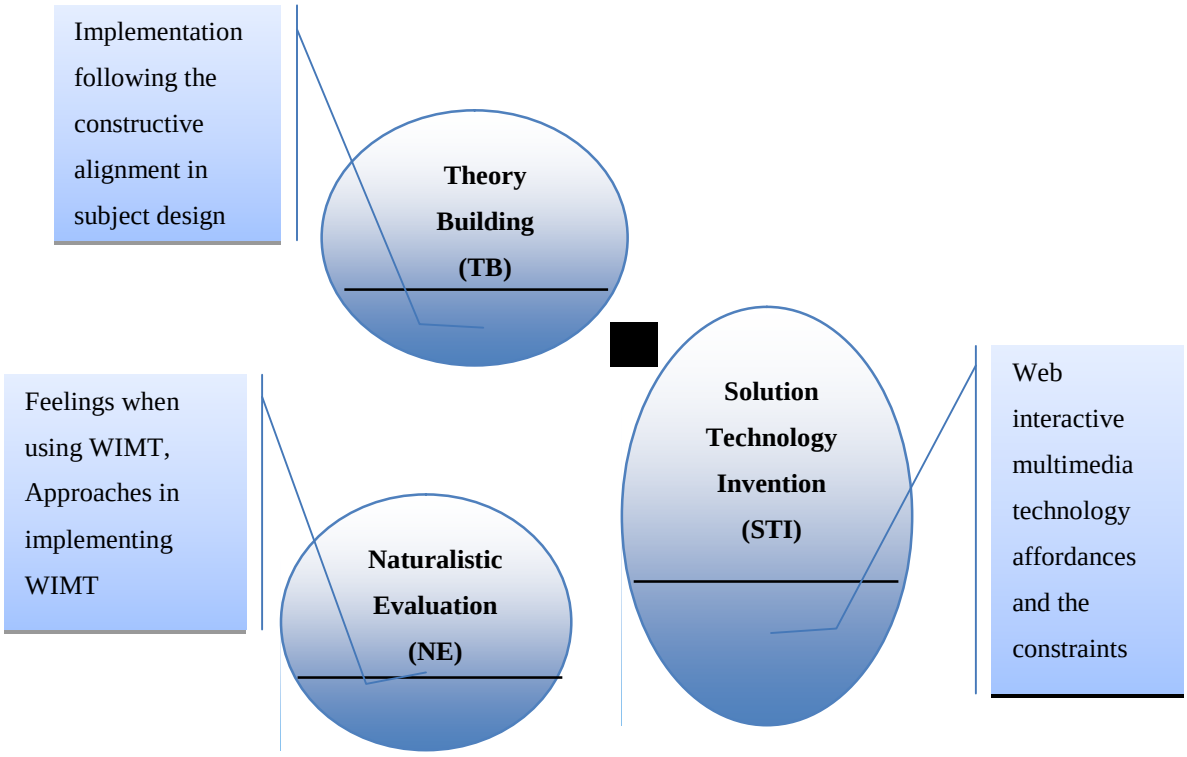

Figure 3.3: Themes constructed from the interview data based on the research conceptual model

In order to sort and organise the data, the transcripts and the notes taken were read through and subsequently divided into textual units that reflected different domains of the participants' experiences and perspectives. These textual units were then coded. Codes that were related by common properties or elements were merged into a category (Morse & Richards 2002). It is important to note that content analysis was not the aim of the data analysis and consequently a single comment was considered as important as those that were repeated or agreed on by other stakeholders. The summary for each stakeholder reflected the processing of the information and provided the opportunity to sense and take note of potential themes.

Stakeholder analysis using qualitative methods was considered appropriate for an analysis of themes derived from an exploration study, about which relatively little was known and about which understanding was desired. Thematic analysis was used in stakeholder analysis according to the research conceptual model.

3.5.6 Themes Development for Each Investigative Domain

Each domain in the research conceptual model was analysed and themes emerged in each domain from the stakeholders' analysis based on the interview transcriptions. For example, in the Solution Technology Invention domain, the 'audio' theme was developed. Audio was used to give lectures. The environmental constraint was background noise that the lecturer needed to mitigate, by enabling the microphone as and when needed by students. In the Naturalistic Evaluation domain of the research conceptual model, the 'better affordances' theme was developed as stakeholder's described the need for multiple affordances. Stakeholders perceived a range of affordances as more than just text-based interaction on the web. The theme developed for the Theory Building domain was 'meeting the intended learning objectives'. Academic developers and lecturers highlighted the importance of using Elluminate affordances to achieve the intended learning objectives of the subject. The aim in each domain of the research conceptual model for categories development is summarised in Table 3.5.

Table 3.5: The aim in each domain of the research conceptual model for categories development

Conceptual model	Aim in the data analysis
Solution Technology Invention	Web interactive multimedia technology affordances and their constraints
Naturalistic Evaluation	Stakeholders' perceptions of the usefulness of the web interactive multimedia technology affordances
Theory Building	Ensure resources aligned with the intended learning objectives

The data predominantly came from case studies of four subjects using Elluminate in their learning activities. The research design was a multiple case study design in which a subject is the unit of analysis (Yin 2009). New data arises out of the process of analysis. The rationale for including or excluding new data was then applied according to the source of information and the quality of each theme. An example is the analytic process of theme development from the participants' responses to the question 'What are the affordances of Elluminate used?'. The responses indicated that, regardless of their approach, they all expressed the belief that the screen-board that resembled a whiteboard and enabled desktop sharing was necessary and valuable. The screen-board is used as desktop sharing was unexpected new data. Consequently, a new category entitled 'screen-board' was introduced, as depicted in Figure 3.4. In further analysis of data, relevant findings were placed in this category.

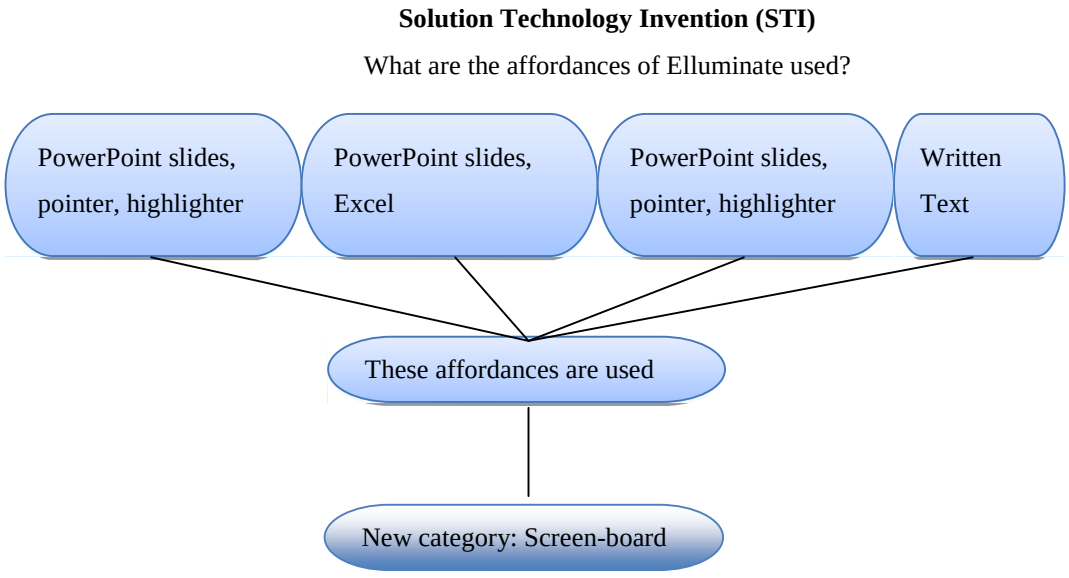

Figure 3.4: Development of a theme in Solution Technology Invention

The common first steps are categorising and conceptualising. 'All qualitative researchers aim to create categories that are more general, drawing together the complex immediate messages

of the data in more abstract topics or groups, and most aim to move from this sorting of data to more theoretical concepts' (Morse & Richards 2002, p. 130).

The categories developed in each domain of the research conceptual model were analysed case-by-case and stakeholder-by-stakeholder. Table 3.6 is a sample of the text in Solution Technology Invention domain of the research conceptual model that was analysed according to the three main stakeholders. Each domain of the research conceptual model was analysed in each subject case study.

Table 3.6: Applying the text component to all three stakeholders

Category: Text		
Stakeholder	Interview Transcript	Analysis
Academic developer	When that is a private one I think answer him privately while trying to teach the whole class pretty much [don't like it], audio (microphone) on and off (Academic developer Case 1).	In Solution Technology Invention domain, category emerged is text. Text messaging consists of two types, private and public. The academic developer informs constraints that stakeholder cannot use two affordances at once.
Lecturer	They type something while I speak and then I could respond to that in audio. If I am talking, I cannot text as well (Lecturer Case 2).	In Solution Technology Invention domain, this is considered under category text. The lecturer informs constraints mean that two affordances cannot be used at once.
Student	(text) opportunity to ask questions not only a few but a large chatter as well and ideas (Students Case 4).	In Solution Technology Invention domain, this is considered under category text. The students used text messaging.

Based on data collected and the analysed themes developed for Solution Technology Invention, Naturalistic Evaluation and Theory Building, the artefact, a generic guideline to assist lecturer with affordances choices depending upon the nature of the learning activity and the size of the class, was developed.

Solution Technology Invention – Delivery Strategies and Constraints

Codes for Elluminate affordances were developed during the data analysis based on the transcripts of the interviews with stakeholders. During data analysis, there were more than twenty codes developed. The codes were grouped into fourteen categories and then further analysed and finally categorised into screen-board, text, emoticons, audio, video, polling and recording. The evaluation was later organised and analysed to ensure that the technology, organisation and people constraints were described (Laudon & Laudon 1998; Richardson et al. 2011).

Naturalistic Evaluation – Stakeholders' Evaluation

In Naturalistic Evaluation, the stakeholders' perspectives were evaluated based on the ease-of-use and usefulness of Elluminate affordances (Davis1989). Based on the stakeholders' analysis through the technology adoption theories, themes emerged.

Theory Building – Learning Constructive Alignment

In Theory Building, the evaluation checked that the learning and teaching resources described in the subjects' guide documents supported the alignment of the learning activities, learning objectives and assessment. The subject guide documents were retrieved from the subject webpage information or provided by the lecturers. The assessment was based on the assignment documents or information provided by the lecturers.

3.5.7 The Artefact: Guidelines as an Outcome

From the subjects' guide documents and the stakeholders' analysis, Elluminate affordances were linked to the learning activities. A matrix was used to summarise Elluminate affordances used in the learning activities in each case study, then followed for all four case studies in each domain of the research conceptual model – Solution Technology Invention, Naturalistic Evaluation and Theory Building.

3.6 Limitations of the Research

At the time of the study, Elluminate was not widely used due to infrastructural constraints. A limitation of this study was the difficulty in obtaining stakeholders for all cases. Due to the ban on travel and the timing of the study and students' graduation, many students were not available for interview. Now Elluminate is embedded in a Learning Management System called Blackboard (ITS 2012). Elements of this research were published throughout the research journey to obtain multiple perspectives from other researchers, peers and experts. Another limitation was that animation was not enabled in Elluminate. This was found during the data collection and data analysis stage of this research. MS PowerPoint slides that contain animation would be flattened when uploaded and displayed in Elluminate. This limited the analysis of web interactive multimedia technology affordances as animation was not available to be evaluated.

The number of participants in this study indicates that the findings or knowledge in this study might be unique or might make it difficult to reach a statistically generalising conclusion. Although it is not statistically generalisable, it is analytically usable in other contexts and research (Myers 2009; Yin 2009). The data analysis is time consuming where the researchers

need to make sense from large amount of data, textual data and transcripts. In qualitative research, the conceptual framework establishment and the objective are more important than a large sample size (Irani, Themistocleous & Love 2003). In qualitative research, a single sample is valid as it focuses on the context and depth of the study, as mentioned by Lester (1999).

3.7 Ethical Considerations

Ethical approval for this research was obtained from the RMIT University Human Research Ethics Committee following the National Human Research Ethics Committee guideline (Approval no. 1000215). A participant information statement and informed consent form were prepared for both lecturers and students (Appendix I & II). The application was reviewed by the College Human Ethics Advisory Network (CHEAN) under the category of negligible and low-risk research. Where possible all electronic data is stored on the RMIT University network. Data will be retained for a period of five years after the project.

Interview participants were provided with both written and oral information about the purpose of the study and its procedures before signing the consent form at the time of the interview. It was voluntary to participate in the research and they had the choice to withdraw from this research at any time. To protect confidentiality, label codes were allocated to the participants (lecturers, academic developers and students) and are used in this thesis.

3.8 Summary

This chapter has outlined the research methodology utilised in this study. A Design Science Research approach was adopted, using case studies in the interpretivism paradigm. By taking such a perspective, the researcher acknowledges the meaning given by the people in the implementation and system adoption.

The data were collected using semi-structured interviews with three groups of stakeholders. The use of Elluminate was observed in a web session. The subject guide documents were also evaluated. Thematic analysis was used for analysing the data. Based on data collected and analysed, and themes developed for Solution Technology Invention, Naturalistic Evaluation and Theory Building, guidelines to assist the decision making of designing subject design were developed as the outcome of this research.

The context of the research, as well as Elluminate use in universities utilising four case studies, are explained in the next chapter. The next chapter further establishes the research conceptual model based on the Design Science Research in Information Systems that was used in the analysis of this research, and further establishes the context of this research.

4 Data and Analysis

This chapter reports the results of the interviews conducted with stakeholders using Elluminate affordances for learning and teaching in each case study. The analysis and interpretation of the data obtained from the interviews enabled the researcher to gain a good understanding of Elluminate affordances implementation. The outcomes of the analysis and interpretations are discussed in order to build a picture of the use of Elluminate affordances learning in higher education. Underpinning the research conceptual model with Design Science Research was undertaken to elicit an artefact in the form of guidelines to improve the implementation of web interactive multimedia technology affordances in learning and teaching environments.

This chapter is organised into eight main sections: Section 4.1 overviews the analysis including Elluminate affordances description; Sections 4.2 to 4.6 analyse the use of web-based interactive multimedia technology affordances in four case studies; Section 4.7 describes the subject stakeholders' analysis; and Section 4.8 summarises this chapter.

4.1 Overview

4.1.1 Solution Technology Invention – Delivery Strategies and Constraints

In this research, Solution Technology Invention was used to define the actual Elluminate affordances that were used in the learning setting in higher education. Solution Technology

Invention enabled investigation of the technical and learning constraints of each affordance used by academic developers, lecturers and students, in each of the case studies.

The categories used to describe the implementation of the Elluminate affordances were screen-board, text, emoticons (such as smiley face), audio, video, polling and recording. The case studies provided an opportunity to evaluate each affordance in a real context. The Solution Technology Invention domain ensured that learning and technology constraints were taken into consideration. The stakeholders in this study faced several impediments to affordance implementation that could be further organised into themes using the Technology, Organisation and People (TOP) framework (Laudon and Laudon1998; Richardson et al. 2011).

4.1.2 Naturalistic Evaluation – Stakeholders' Evaluation

The Naturalistic Evaluation domain of the Design Science Research framework that underpins the conceptual model of this research is defined as focusing on the stakeholders' evaluation of the adoption and implementation of the Elluminate affordances. The themes were built based on the transcriptions of interviews with stakeholders, comprising academic developers, lecturers and students. In Naturalistic Evaluation, the usefulness and ease-of-use of Elluminate in higher education were the main foci.

4.1.3 Theory Building – Learning Constructive Alignment

The Theory Building domain in the Design Science Research conceptual model is defined as focusing on the constructive alignment of learning. Specifically, Biggs' (1996) and Biggs and

Tang's (2007) Constructional Alignment Theory was used to evaluate the case studies' learning and teaching schedules as the focus was on the subject design. From the stakeholders' analysis, there is certainly the need to plan in the design stage before implementing Elluminate affordances in the actual learning activities rather than making decisions about affordance use during class delivery.

4.1.4 Elluminate as an Exemplar of Web Interactive Multimedia Technology

Elluminate allows lecturers to deliver asynchronous lectures and facilitates discussions with students (Murphy & Ciszewska-Carr 2007). Therefore the lecturer and students are opened to other learning experiences using web technology, such as the use of a web-cam to provide a live feed from a student industry site when they need to present their work during practical training session. Elluminate affordances offer a range of positive possibilities in terms of learning although this proposition is largely untested (Marino & Hayes 2012).

The latest version is capable of displaying videos and enabling an interactive screen-board. Elluminate is accessible through the web from a centralised server. The Elluminate application enables more than just text-based or audio-based information to be delivered to the students in an almost real-time manner.

4.2 Web Interactive Multimedia Technology in Subjects Case Studies

The next four sections contain the description of each case study. Each description contains information about the subject background, the level and the number of students. The analyses were conducted using the Solution Technology Invention, Naturalistic Evaluation and Theory

Building domains of the conceptual research model. All three domains highlighted the implementation of affordances in learning activities to achieve the desired learning outcomes but focused on different perspectives. Solution Technology Invention focused on the technical and learning constraints experienced during delivery. Naturalistic Evaluation focused on the stakeholders' perspectives of the value of Elluminate affordances to learning and teaching. Theory Building focused on the constructive alignment of subject design that used Elluminate, to provide an initial assurance that the case studies were well designed and delivered subjects prior to the implementation of Elluminate. Using exemplars for learning and teaching in the form of case studies was intended to allow a focus on the impact of the affordances. From the stakeholders' analysis, these term are defined.

Screen-board

The term "screen-board" refers to a small display window on a monitor not a physical whiteboard. The screen-board is similar to other interactive board technologies, although the literature on interactive board technologies has focused on the board and this research focuses on the web usage. Interactive affordances are not necessarily used interactively (Sessoms 2008). The screen-board enables application sharing (Crook et al. 2008).

Text

The text affordance was used by all stakeholders. Some called it 'chat' or 'textbox'. It was an area where lecturers and students sent messages to each other publicly or privately.

Audio

The audio affordance is where the stakeholders could use the microphone to speak to the others and the others could hear through the speaker.

Emoticons

The emoticons affordance refers to the use of the icons such as smiley faces and thumbs up.

Video

The video affordance refers to the use of a web-cam to display the images of the participants involved in a web session.

Polling

The polling affordance was also called ‘audience response system’ where the academic developers or lecturers displayed a question with possible multiple choice answers and the students chose what they considered to be the correct response. The students’ responses could be displayed in the same web session or later or just retained by the academic developers or lecturers.

Recording

The recording affordance enabled the lecturers or academic developers to record a web session for future use. The students were given access to the recorded session for their revision during the semester.

Following are the explanation of each of the four case studies. The four case studies are a neuroscience postgraduate subject (Case 1), a postgraduate business subject (Case 2), a foundation computing subject (Case 3), and a postgraduate consultancy subject (Case 4).

4.3 A Neuroscience Postgraduate Subject (Case 1)

The subject was called Neuroscience Nursing Studies (NURS1033[1], NURS1034[2]) and was taught as part of a postgraduate degree in nursing. The aim of the subject was to provide the information and scientific principles necessary for clinical nurses to competently access and manage patients with complex health needs, in the neuroscience setting. The integration of the applied sciences – medicine, pharmacology, social sciences and nursing topics – was emphasised in order to promote an understanding of the underlying principles of neurological function and dysfunction.

4.3.1 Case 1Neuroscience – Learning Environment

The subject was taught to both on-campus and off-campus students. Learning and teaching activities were predominantly offered in the (physical and virtual) classroom sessions and were augmented in each case by online resources. The subject had been delivered in this

[1] Neuroscience Nursing Studies 1 Subject Guide

[2]Neuroscience Nursing Studies 2 Subject Guide

mode several times to accommodate student nurses working in the clinical area. One lecturer taught the subject. The affordances used in Case1 were: text that allows interactive chat or instant messaging in a public or private manner; audio that enables audio conferencing with microphone and speaker control; participants' profiles that enable the lecturer to enable or disable some affordances to the students; video that enables video conferencing; emoticons that enable the expression and receipt of attitudes or feelings; hand raise that enables the students to raise a hand, with an ascending number allocated to each student in order of hand raising; editing tools such as writing, deleting and pointing tools; and a whiteboard that enables the end user to write on it or to display MS PowerPoint slides.

4.3.2 Case 1 Neuroscience – Student Class Size

A total of nineteen students, including on-campus and off-campus, were enrolled. Elluminate was used for the students enrolled in distance education. Approximately ten distance education graduate students were enrolled in the subject and they were a mixture of international and domestic, and young and mature-age students. Learning and teaching activities were scheduled for lectures each week. Elluminate was used for the graduate programs.

4.3.3 Case 1Neuroscience – Why Elluminate?

Elluminate was chosen as the tool for the distance education students' virtual classroom as it was an emerging technology implemented by the university, replacing the previous virtual classroom system. The academic developer had conducted several sessions to train the lecturers who had volunteered to use Elluminate. Although the lecturer interviewed used the program to communicate with her distance education students, she did not attend the formal

training or participate in the pilot study. The need to facilitate classroom activities in both traditional and virtual spaces was the major driver for this lecturer to adopt Elluminate.

4.3.4 Case 1 Neuroscience – Solution Technology Invention: Delivery Strategies and Constraints

Elluminate was used as a lecturing tool for distance education students and it provided a space for the students to come together and ask questions. Students had the opportunity to understand more because they had completed preceding required self-directed learning. Their learning resources were guided by reading the learning objectives, the lecture notes and the online resources disseminated via Blackboard prior to class.

The subject guide was a document that contained the subject overview, which included the credit points, subject descriptions, learning objectives, expected learning outcomes or capability development, scheduled learning activities, resources and an overview of assessments. There were four learning activities described in the subject guide, which were lectures, class discussion, directed learning exercises and additional readings. Only lectures, class discussion and directed learning exercises were covered during Elluminate sessions. Additional reading was expected to be completed by students as preparation for the live online sessions due, to limited contact time. This task was not supported by Elluminate, as the resources were not available within the application, but they could still be completed online irrespective of class delivery mode.

The academic developer pointed out the need to use affordances to achieve the desired learning objectives. The activity delivery modes used by a lecturer in a normal classroom can be replicated in Elluminate. The activities that could be conducted in a classroom for example, the number of students that could be in a group in an Elluminate session could be

organised in similar way as in the physical classroom. *"If there were five students in a group normally in a class, then do five in a group in Elluminate. You can mirror most (of the) things in the classroom you can mirror in Elluminate"* (Academic Developer Case 1).

The affordances used were categorised into screen-board, emoticons, text, audio, video, and polling. They were mostly available in a range of applications such as instant messenger, video conferencing and audio conferencing. In Case 1, text exchange was rarely used. The interaction was more audio based. This was because the pedagogy and planning was conducted smoothly (with minimal technical problems) in the web sessions with a small number of students. The students were generally mature age, which may have impacted on technology choices. Text was used occasionally when faced with technical constraints. As mentioned by the lecturer *"If we have some problem with Elluminate where some people (are having problems) or computers dropping out on occasionally, some of them have problems with sound and things so we use the textbox"* (Lecturer Case 1). In Case 1, audio was mainly used by both the lecturer and students for engagement and interaction. All students were given the ability to speak up at anytime during the web session as mentioned by the lecturer *"I had all of the students showing so I have maximum simultaneous talkers"*. Elluminate only allows up to six simultaneous speakers, but the total number of students in a web session in this case was fewer than six. In Case 1, the emoticons were used by the lecturer to ascertain whether the students understood the concepts introduced in a learning activity before proceeding with the next part of the lecture. The emoticons were used to prompt the students as the lecturer could not see facial expressions and body language. As an example, the lecturer would ask the students *"This (concept) is really important if you do not have this concept you are not going to understand the next bit. Those that need more explanation please raise up your hand (using the emoticons)"* (Lecturer Case 1). The lecturer purposely did not use the recording

affordance due to copyright. The medical images used in the subject resources were sourced from third parties. The lecturer provided the medical images during the lecture sessions and did not put graphics in the online lecture notes in Blackboard due to copyright.

4.3.5 Case 1 Neuroscience – Elluminate Affordances

The web interactive multimedia technology affordances used for learning activities in Case 1 were identified during the interviews with stakeholders and from subject guide document. Of the seven Elluminate supported affordances, six were used to support delivery of courseware in this case. The affordances used were:

- screen-board for lectures, discussions and exercises during the web sessions
- text in the lectures and discussions
- emoticons in lectures, discussions and exercises in the web sessions activities
- audio in lectures and discussions activities
- video in lectures and discussions activities but only for acknowledging that the students were in front of the monitor
- polling in exercises during the web sessions to get feedback from the students or to test their understanding and to gain their attention

The affordances used are summarised in Table 4.1.

The visual medical images were covered in the web session by the lecturer where images were displayed on the screen-board. In Case 1, the screen-board was used interactively to display lecture slides and to enable the lecturer to point to hot spots in the medical images when answering students' questions. As the lecturer noted *"If I was going through a CT for example...I use a pointer to point at the hot spot or the area that was significant"* (Lecturer Case 1). During the development of the subject material, medical images were embedded in

lecture presentations. These were designed for delivery during web sessions or in the traditional classroom. Significant areas were highlighted with the screen-board pen or highlighter. All learning and teaching resources were prepared at the beginning of the semester. The lecture was scheduled for presentation to on-campus students six hours a week. Elluminate was used for class delivery for the distance education students. Both on-campus and off-campus students were expected to prepare for each class by completing the assigned reading. The same learning and teaching resources were prepared and used for all sessions. Elluminate delivery did not require additional preparation. The lecturer used the resources she prepared for a physical face-to-face class.

The use of video during lectures by the lecturer was restricted to looking at the students' pictures to assure the lecturer of their presence. Although the video affordance was used for no other activities, it may have had positively influenced the recognition of students' voices when the audio was used for discussions. It may have also made students feel more comfortable to communicate in the unfamiliar Elluminate environment. A web-cam was used to see whether the students were in attendance or not. *"I also had maximum visual where I had all the video (from web-cam showing the students in front of the computer) of the students every week. I also allowed maximum simultaneous talkers. I did not turn students off (no features were disabled). They were allowed to cut across each other"* (Lecturer Case 1).

Table 4.1: Summary of Elluminate affordances used in learning and teaching activities in Case 1

Elluminate affordances	Lectures	Discussions	Directed learning exercises
Screen-board	☒	☒	☒
Text	☒	☒	-
Emoticons	☒	☒	☒
Audio	☒	☒	-
Video	☒	☒	-
Polling	-	-	☒
Recording	-	-	-

During lectures, a didactic presentation or one-way communication style was prevalent. The affordances recommended to facilitate lecture delivery were text, emoticons, audio and screen-board. Elluminate enabled students to become involved in class discussions that required two-way communication. Students could ask questions and listen to peer or lecturer responses. The student initiation of questions enabled student-driven discussion. Students could impact on the success of their own learning by engaging in discussions during the web session. The affordances available for class discussion were text, emoticons, audio and screen-board. The lecturer informed the students of their expectation that they would learn on their own by completing preparation activities. For directed learning exercises, the affordances recommended were emoticons, screen-board and extra affordances such as polling and recording the lectures. These affordances were useful to interact with the students and present visualisation to enhance students understanding. Web 1.0 affordances enabled the display of information in a static manner. However, in Web 2.0, using web interactive multimedia technology, several affordances were available to be used in an interactive way rather than just the lecturer talking using the audio.

4.3.6 Case 1 Neuroscience – Naturalistic Evaluation: Stakeholders' Evaluation

This section focuses on stakeholders' assessment of the value of Elluminate for learning and teaching in higher education. It is important to understand the views of all stakeholders as this impacts on successful adoption (Waring 2001). The lecturer was impressed with Elluminate. *"It is a fabulous technology"* (Lecturer Case 1). The Elluminate environment catered for more than text, which had been the only available delivery medium in the earlier Web 1.0 virtual classroom. Elluminate enabled more than dissemination; it was used for almost real-time interactive chat sessions. The lecturer could upload and show images as well as point to and highlight hot spots and significant areas which were crucial to students' understanding of neuroscience. Elluminate was also easy-to-use as the lecturer did not require any training to operate the software application. However, assistance was needed to use the affordances to achieve the required learning objectives. *"I got a lot of support from the learning people in town ... but I missed out on the (formal) education"* (Lecturer Case 1). This lack of training was overcome by contacting the academic developer, who then worked with the lecturer, during an Elluminate session. The lecturer and academic developer tested affordances to find the best ways to facilitate interaction with the students, to achieve the intended learning outcome. When technical problems occurred, the lecturer contacted the information technology support team, the front line for technical problems faced by staff. The academic developer agreed with the lecturer and found Elluminate useful. *"It shows its use because it is use at the time when you needed it … Excellent"* (Academic Developer Case 1).

4.3.7 Case 1 Neuroscience – Theory Building: Learning Constructive Alignment

In learning, a constructive alignment design approach ensures that learning activities and assessment are aligned with the objectives, capability development or intended learning outcomes of the subject (Biggs 1996; Biggs and Tang 2007). In this case, the program was a postgraduate degree in nursing. The learning activities and assessment tasks were evaluated as to whether they were appropriate to encourage student achievement of specified learning outcomes.

The subject guide described objectives, activities and assessment, which evidenced that constructive alignment principles, had been used to design the subject. Figure 4.1 illustrates a sample of the design of the subject underpinned by constructive alignment principles, whereby the learning and teaching activities and assessment were aligned with the intended learning objectives.

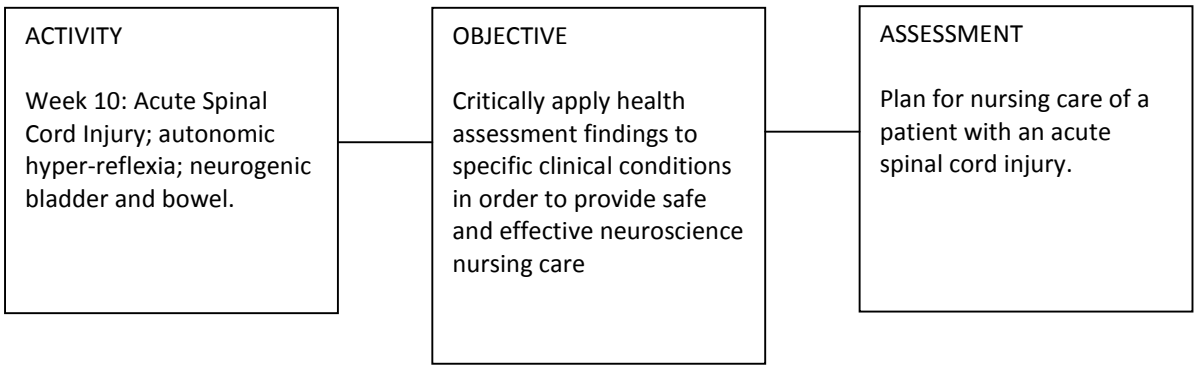

Figure 4.1: Case 1 Neuroscience – A sample of constructional alignment

The subject was devised using constructive alignment principles during the subject design phase. Learning activities and the assessment were designed to achieve the intended learning

objectives (Biggs 1996; Biggs & Tang 2007). Figure 4.1 maps a sample of the intended learning objective with the learning and teaching activities as well as the assessment methods as stated in the subject guide. For example, a learning objective stated in the subject guide was "to critically apply health assessment findings to specific clinical conditions in order to provide safe and effective neuroscience nursing care". The learning activities and assessment tasks were designed to meet the intended learning objective.

The academic developer stated that lecturers should design learning activities to achieve the desired learning objectives and then decide what technology solution would be appropriate. *"What about we try if this fits for you* (t*he lecturer). Would that feature suit you better? … It is thinking of the teachers first before the technology"* (Academic Developer Case 2).

The lecturer provided the learning activities and assessment tasks for students to construct their own meaning and to have the best chance of achieving the desired learning outcome (Biggs 1996). The lecturer stated that images were required for effective learning and teaching resources. Elluminate was appropriate for the material to be learnt. *"I also make sure that we cover the visual"* (Lecturer Case 1). The images provided real medical images for descriptions of nursing care, which were important for students' learning to operate in real clinical situations. Students used the visual images as cues to practise making clinical decisions. Ellumintate has the ability to display images on its screen-board.

The lecturer had prepared the subject material before the semester began so that the students could access resources to complete preparation activities. All the subject material was put online using the Learning Management System, Blackboard. Students could access preparation resources from their own computer: laptop, desktop, tablet or mobile phone. The

amount of time students' needed to spend preparing for Elluminate classes was not considered by this lecturer to be a large burden. Learning activities and assessments were created for both traditional and online delivery. *"The preparation was not really anything special"* (Lecturer Case 1).

In Case 1, activities conducted during Elluminate supported sessions were not assessed by marks. Students were assessed informally using simple questions and polling, to encourage them to initiate conversations and engage with learning activities in order to deepen their understanding. These interactive activities were designed to enhance the students' learning. Affordances such as images and audio facilitated the learning activities delivered. The number of students involved in Elluminate classes was small. The lecturer directly provided students with feedback to clear confusion and helps them construct their own learning.

4.3.8 Case 1 Neuroscience – Web Interactive Multimedia Technology in Learning

The activities were predominantly lectures that included neuroscience graphics and images such as, CT scans. The medical images were not included in the lecture notes available for students to download, they were used for decision practice and as the basis for discussion during classes. The opportunity for question and answer sessions assisted the students' self-directed learning. The pre-reading was crucial to students' ability to ask questions and request further explanations during web session discussions. Both the pre-reading and subsequent discussions based on highlighted images were deemed effective methods for enabling students to construct meaning.

To be able to upload and display images on the screen-board was important for learning compared to using only text, especially in Case 1 where the subject taught demands the visualisation of medical images for further understanding of the subject. Screen-board was there for the lecturer to get the students to focus on the material being taught. In medical studies, images and scanned images such as x-rays and CT scans are important for students to understand the pattern and the images for a particular medical case or scenario.

The lectures were designed to accommodate time limitations caused by class schedules. The weekly web sessions were used to clarify learning expectations, to remind students of the activities outlined in the subject guide and to obtain feedback from the students. The Elluminate classes checked students' understanding using audio, text and polling affordances.

The lecturer noted that the ability to conduct a lecture using audio and displaying images was important for constructing an environment which maximised students opportunities to achieve the learning outcomes of the subject. *"Just go for it. Have a practice first. Make sure you use it to get the best of its advantage. But go for it. It's fantastic"* (Lecturer Case 1). The lecturer encouraged colleagues to investigate this software and use it, especially in their distance education subjects, because it enabled more than just the normal e-mail, bulletin board, discussion forums or even phones. This study looked at various types of activities that might be appropriate for the web interactive multimedia technology affordances of screen-board, text, emoticons, audio, video, polling and recording.

There was an obvious need to plan and prepare learning activities before each web session. The academic developer and lecturer in this case agreed that preparation was required prior to commencement of the scheduled class in the web space, to set up the audio and make sure it

worked. *"You are concentrating on uploading your (MS PowerPoint) slides, checking if anything else is ready"* (Academic Developer Case 1). This is similar to planning and conducting sessions in physical classrooms where lecturers check if the computers work, ensure they have the appropriate overhead transparencies, clean the whiteboard or check the projector, or even check the lighting prior to class starting. *"I get into Elluminate and start to upload the (MS PowerPoint) slides and sometimes test the audio (using audio wizard) before I start the class"* (Lecturer Case 1).

During each web session, the lecturer needed to manage and complete the activities to facilitate the students achieving learning outcomes. In a web session where interaction and collaboration is feasible, the lecturer needs to facilitate the conversation to encourage students to participate and ask questions, so that the lecturer can provide feedback. The academic developer highlighted the need for lecturers to monitor private text messages between students and to be able to withdraw a student from a web session or disable the whiteboard session to manage the Elluminate classroom. *"You can even send a private message to Jimmy and say "Jimmy if you do not behave I am going to take the whiteboard tools away from you" If he keeps that up and you can go there (the profile tool) and his whiteboard tool will go off"* (Academic Developer Case 2).

The lecturer in this case did not disable any of the affordances for students, as it was not necessary. All students were allowed to interrupt a conversation to ask a question because it was a small group of students in each web session. It was relatively easy to enable conversation from the lecturer's point of view. Although all affordances were available to all of the students in the web session, the lecturer did not have any problems managing the affordance resources, the students' collaboration and the facilitated lecturer-student and

student-lecturer interactions. Managing students' access and Elluminate affordances, including activities in a real-time web session, was straightforward. According to the interview, a small group size was critical for ease-of-use. *"Because I have a small group, it was easy to do"* (Lecturer Case 1).

Elluminate enables ubiquitous learning where students virtually meet the lecturer from different places and at different times to participate in a classroom activity or assessment. Elluminate enables almost real-time communication between students and a lecturer across geographical and physical boundaries. It was found that the virtual learning activities preparation sometimes took longer than the allocated class time when time for setting up the equipment, starting up the computer and logging in to Elluminate was included. *"It depends on how much time they prepare for a class"* (Academic Developer Case 2). Sometimes during the web session, technical problems had to be overcome. Elluminate, with its multimedia interactive affordances, mimics the real physical classroom without the facial and (most) other physical expressions. Some visual communication was not possible but the tone and speed of a voice in addition to text and emoticons provided insights into students' reactions (Mchichi & Afdel 2012).

4.3.9 Case 1 Neuroscience– Conceptual Model

The development of the conceptual model for the use of Elluminate affordance to teach Neuroscience was iterative (Ang & Slaughter 2001). The research conceptual model had three main domains: Solution Technology Invention, Naturalistic Evaluation and Theory Building. Several themes were identified in each domain subsequent to the analysis of Case 1, the Neuroscience subject. The web interactive multimedia technology affordances used in Case 1

were screen-board, text, audio, emoticons, video and polling. In Solution Technology Invention domain, the affordances available enabled visualisation and clear demonstration for learning. The small number of students and the support provided contributed to mitigating the technical constraints. Video assisted in receiving non-verbal communication such as facial expression. In Naturalistic Evaluation, audio was useful for the lecturer to present and provide feedback to students, and the screen-board was beneficial for presenting MS PowerPoint slides and pointing to specific spots for further clarification. A positive attitude and the mitigated constraints resulted in a positive experience. In Theory Building, there is a need to align the use of web technology with the objective of the subject. The subject was designed in accordance with the constructive alignment. The Elluminate affordances were not included in the design of the subject.

Constructive alignment was the theoretical lens in analysing the data in the Theory Building domain. The themes provided further evidence of the need for constructional alignment principles to be used during subject design (Biggs 1996; Biggs & Tang 2007). All stakeholder perspectives were taken into account to enable the identification of themes in each Design Science Research domain. Figure 4.2 illustrates the development of the conceptual model based on Case 1 Neuroscience.

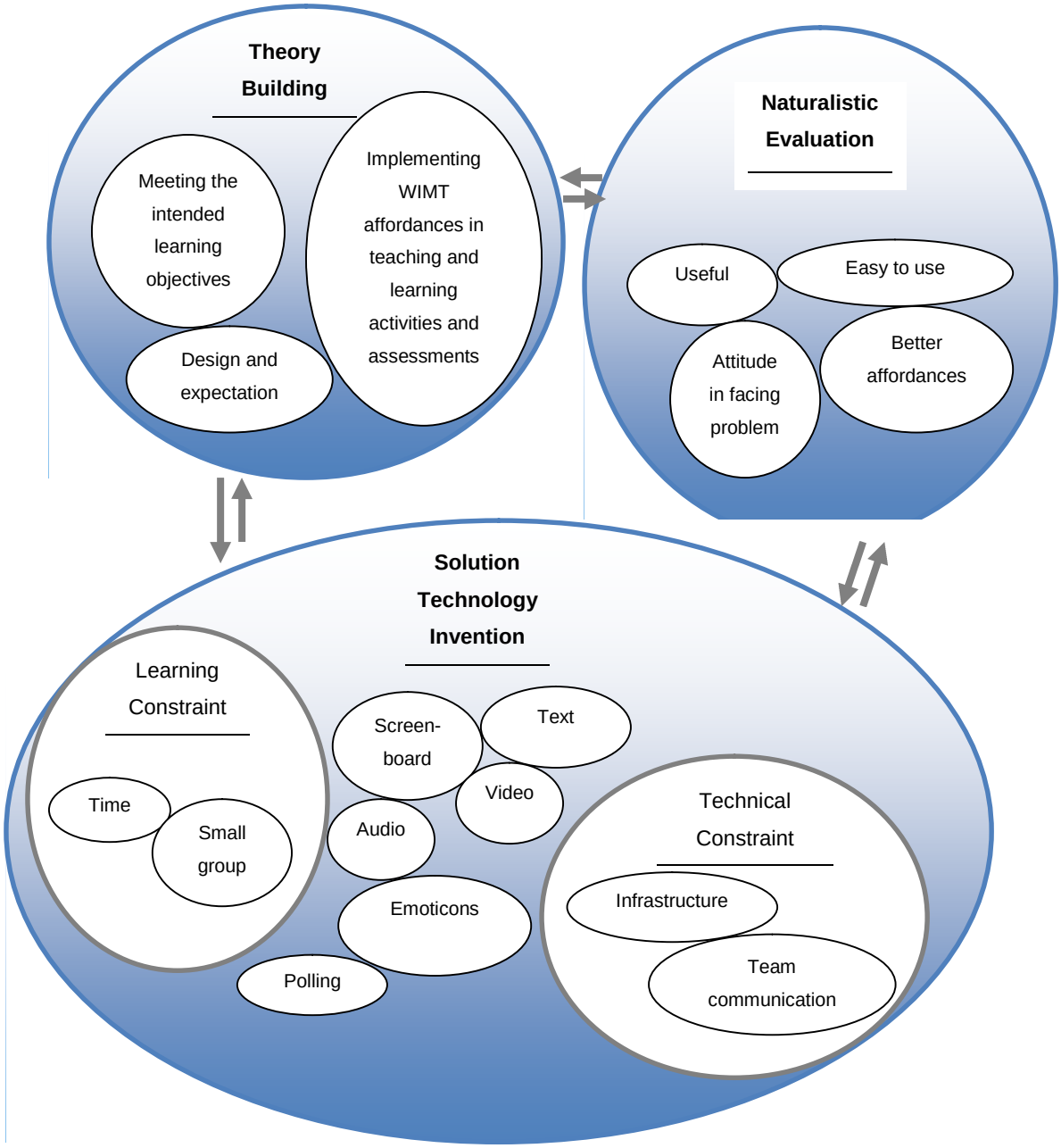

Figure 4.2: Case 1 model

The appropriate use of Elluminate affordances for learning activities was summarised according to group size and level of interaction learning. The group size was divided into large and small and the level of interaction was divided into low and high. A low interaction level lent itself to learning activities that required one-way communication. A traditional lecture where information is transferred from the lecturer to the students is a typical example of low interaction requirements for delivery. High-level interaction requires two-way

communication between lecturers and students, which usually occurs in discussion activities. The relationships between group size and learning activities are illustrated in Table 4.2.

Table 4.2: Summary of web interactive multimedia technology affordances for learning in Case 1

Affordances	Small group	Lecturing (Low interaction)	Discussion (High interaction)
Screen-board	☒	☒	-
Text	☒	☒	-
Emoticons	☒	☒	-
Audio	☒	☒	-
Video	☒	-	-
Polling	☒	☒	-
Recording	-	-	-

The seven affordances used in Case 1 Neuroscience were screen-board, text, emoticons, audio, video, polling and recording. In Case 1 Neuroscience, Elluminate was used with a small group of students for lecturing type of activities. Based on the analysis and evaluation of Case 1, the screen-board, text, emoticons, and audio were suitable for small groups of students when lecturing type activities were conducted as they require low-level interaction. Video, was also suitable for small groups of students. In Case 1 Neuroscience, video was only used to acknowledge the presence of the students at an online session. For assessment purposes and attendance security, this was a useful affordance. Recording was not used in Case 1.

4.4 A Postgraduate Business Subject (Case 2)

The subject in Case 2 was called Cross-Functional Project Management (INTE1006[3]) and was taught to an off-shore partner as part of a master's degree in Business Administration. This subject built on the students' knowledge and experience of project management,

[3] Cross Functional Project Management Subject Guide

communication, organisational dynamics, self-management and team management based on the project management body of knowledge framework. Cross-functional project management would typically expand a student's view of the different styles and techniques required to manage cross-functional projects that have executive management capabilities. The subject dealt with global projects and the merits of outsourcing.

4.4.1 Case 2 Business – Learning Environment

The subject was taught to an off-shore partner university campus. The subject was normally taught in a traditional face-to-face delivery mode in Singapore, the off-shore partner campus. Due to the bird flu outbreak and swine flu epidemic in 2009, the lecturer could not travel to Singapore and Elluminate was used to deliver the subject and communicate with the students. Delivery of the subject in this manner enabled planned graduations to occur on time. The subject was usually delivered in 39 hours intensively. The affordances used in Case 2 were: text that allows interactive chat or instant messaging in a public or private manner; audio that enables audio conferencing with microphone and speaker control; participants' profiles that enable the lecturer to enable or disable some affordances to the students; emoticons that enable the expression of agreement or disagreement; and a whiteboard to display MS PowerPoint slides.

4.4.2 Case 2 Business – Student Class Size

There were five students in the subject. The subject was offered in a ten-day period, in intensive mode using Elluminate, due to the swine flu epidemic.

4.4.3 Case 2 Business - Why Elluminate?

Elluminate was chosen as the tool for communicating with the students located on site in the off-shore campus due to the ban on all staff to travel to the off-shore campus. There were several students who wanted to graduate and needed to complete the subject at the scheduled time in order for this to occur. However, in this case, after the travel ban was lifted, the preferred option returned to the face-to-face mode of delivery.

4.4.4 Case 2 Business – Solution Technology Invention: Delivery Strategies and Constraints

Elluminate was used as a lecturing tool for postgraduate students. Although other technologies such as, video conferencing were available, Elluminate was seen as the most promising tool for communicating with several students located in different physical places offshore.

The academic developer was informed that Elluminate was to be used to conduct web sessions in real-time. Everybody had to be in the same session to collaborate and communicate in order to complete learning activities and assessment tasks, as a group. Since it was a real-time session, the academic developer commented that it involved intense learning as the lecturer and students needed to be concentrating most of the time. *"Intense learning, you have got to be really concentrating if you are the moderator or the participants"* (Academic Developer Case 2).

Elluminate was used for lectures and presentation sessions. Although the students were involved in peer discussion groups, the research interview was conducted only with the lecturer. Only the affordances used in lectures and presentation activities were evaluated as

the lecturer could comment on the effectiveness and constraint of Elluminate affordances used in this manner. Since the lectures and presentation activities were mainly one-way communication, the affordances used were mapped against that type of activity. Only five affordances were used for lectures. The Elluminate affordances used were screen-board, text, emoticons, audio, video, polling and recording. The use of video was to present recorded videos on the screen-board. In Case 2, the screen-board was not used interactively. The lecturer delivered the lecture in a traditional format. The lecturer in Case 2 did find the affordances useful as Elluminate enabled the lecturer to provide lectures to off-campus students. The affordances in Elluminate were also useful compared to telephone, e-mail and video-conferencing. In Case 2, text was only used by the students.

The lecturer preferred to respond in audio. This was because the lecturer found it was difficult to speak and text at the same time due to not having *"enough personal bandwidth, mental bandwidth to enable to do all sorts of things"* (Lecturer Case 2). The lecturer pointed out that *"if you were in a meeting or something, you were talking with somebody on the phone (then it was OK to talk and text in the same time) as it is not suitable in the situation where he is working in"* (Lecturer Case 2). In Case 2, audio was used mainly by the lecturer for giving presentations. However, the students were given the microphone (microphone enabled) upon request. The lecturer allowed one speaker at a time. This was conducted to mitigate audio problems being faced by the lecturer and students. The audio problems were the delay in getting the response to come through the speaker and background noises. Another strategy for enabling audio communication was by having good quality equipment (such as microphone). *"Important to have a quality microphone"* (Lecturer Case 2). In Case 2, the emoticons were used by the students to get the lecturer's attention. This was because the lecturer enabled only one student speaker at any time and the students needed to request access to the microphone

before they could speak *"They put their hands up waiting for me to put my microphone off"* (Lecturer Case 2). Polling was also used during the web sessions to check students' understanding of delivered knowledge. The whole web session was recorded for students unable to attend the scheduled session. The Elluminate affordances used in learning activities in Case 2 Business, based on the interviews and the subject guide document, are summarised in Table 4.3.

Table 4.3: Summary of Elluminate affordances used in learning and teaching activities in Case 2

Elluminate affordances	Lecture
Screen-board	☒
Text	☒
Emoticons	☒
Audio	☒
Video	☒
Polling	☒
Recording	☒

A practice session for students was important to ensure that they became familiar with the technology before an actual session was conducted. "*Important to get (the students) used to the technology before they actually using it to make sure everything is working and making them used to the software (Elluminate)*" (Lecturer Case 2). Training ensured that the students were comfortable asking questions and were not focussed on trying to figure out how to use the relevant affordance to talk.

Elluminate was best used in a discussion mode where two-way communication between lecturers and students could facilitate students' understanding. Learning was also facilitated through student-student communication in real-time sessions. "*They were actually doing presentations back to the rest of the group. And some of them are using – marker on the screen-board. I also have some group activities. I give them little problems. They are breakout rooms. They are actually in different places but you get them to work together. That*

was quite good" (Lecturer Case 2). Students could advise and provide tips to each other. This was further supported in Case 4 where the students highlighted that the ability to get together and exchange opinions was beneficial. "*It (is) good when it work. Good to get together*" (Student Case 4).

4.4.5 Case 2 Business – Naturalistic Evaluation:- Stakeholders Valuation

The academic developer mentioned that Elluminate was useful for learning activities. "*You can use Elluminate(for learning activities). It does not have to be distance learning. If you got a tutorial group for example on Tuesday 12 o'clock, there is no reason why you cannot run that using Elluminate"* (Academic Developer Case 2). The academic developer thought Elluminate's ability to enable audio and screen-board was easy-to-use and useful.

As in Case 1, the lecturer was quite happy with Elluminate as it provided the opportunity to teach in a lecture format. It was found to be better than e-mail, a forum or a bulletin board where text dialogue is the only option. However, in this case Elluminate was used because travel was not possible. When the lecturer was allowed to travel, the delivery reverted to the traditional delivery mode. The lecturer preferred face-to-face delivery. It was easier using charisma, character, personality and facial expression to enhance the communication with students, rather than just audio which does not provide visual cues during interactions. "*In front of the class and talk, you can get away with a lot more ... When you spend talking in front of a group you can use your personality to get things across in a lecture. It is really much harder to do that in a purely virtual (web) environment"* (Lecturer Case 2).

Emoticons, a non-verbal communication tool, had a positive impact on the learning and teaching experience. When the technology was working in a stable mode, then it was highly

likely the stakeholders would use it again. The lecturer in this case had a good experience with the students in the off-shore campus. But when he wanted to implement Elluminate with his on-shore students, the lecturer faced technical problems with the university infrastructure that led to the project being abandoned, and Elluminate was not implemented with the on-campus students. *"The university network just could not handle it basically. It is probably worse now that they had put the voice over IP phones. The whole network got a lot worse ... I may not be using it again. I am going back to the offshore campus again. I would not be using it on campus here"* (Lecturer Case 2).

4.4.6 Case 2 Business – Theory Building: Learning Constructive Alignment

Based on evaluation of the subject guide and assessment documents for the Project Management subject in Case 2, the subject displayed constructional alignment (Biggs 1996, 2002). A sample of the design of the learning activities and assessment following the theory of constructive alignment is illustrated in Figure 4.3 (Biggs 1996; Biggs & Tang 2007).

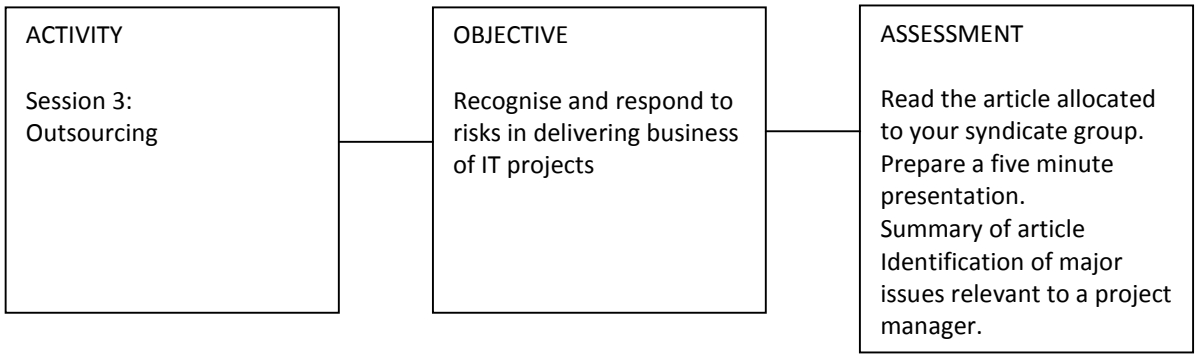

Figure 4.3: Case 2 Business - The design of the learning activities and assessment alignment

The academic developer mentioned that Elluminate had the potential to provide feedback to students in real-time, during lecture type activities using the polling affordance. *"Elluminate has what is called a polling where you can create an activity where you ask students*

questions. The questions can be multiple choices, A, B, C, and D. Students clicked on their response and that gets sent to the lecturer. The lecturer can publish the poll immediately. It is a useful activity tool" (Academic Developer Case 2). E-mail and discussion forums were supported by the university IT infrastructure. However, it was decided to use Elluminate as well as the other available mediums to conduct classes and assist students in fulfilling their study requirements. The activities completed using Elluminate were focused on the lecturing activity scheduled as part of the required activities for students to complete the subject. The assessment was conducted through submission of written assignments and oral presentations, to establish whether the learning objectives had been achieved. Oral presentations by students were conducted using Elluminate. *"I give them a little problem and they were sent to breakout rooms. They are actually in different places but you get them to work together"* (Lecturer Case 2). The replication of the traditional interactions between the lecturer and students and in peer-to-peer groups was technically possible and worked well. The lecturer used Elluminate to provide lecture. The lectures were conducted in long hours with small breaks. The lecturer also suggested that Elluminate could be used to group the students into groups and provide each group a space to discuss using 'break-out'. Group work was an essential component of the IT project subject.

4.4.7 Case 2 Business – Web Interactive Multimedia Technology in Learning

Web 2.0 affordances provide opportunities for collaboration and open access to information (Ullrich et al 2008). The affordances of Elluminate in this case were used to facilitate collaborative activities. The technology enabled the lecturer to disseminate information in a traditional lecturer-student group style whilst the individuals were located in another country. *"They actually work in groups on Elluminate then they present it to me and to each other.*

They take turns when presenting. … With Elluminate, they also use a lot of e-mail. They use Skype too during out of class time, just between themselves" (Lecturer Case 2).

The activities were mainly lectures. It was conducted in traditional *"open cap and pour it in"* (Lecturer Case 2) lecture delivery but on the web, not in a physical classroom space. The lecturer was reasonably experienced with other web interactive multimedia technology lecture deliveries and was not intimidated by the environment. "*Elluminate was better...than video conferencing...I have done a lot of audio conferencing*" (Lecturer Case 2). The individual presentations were conducted smoothly in Elluminate but the recorded presentations (e.g. from previous guest speakers) were not because there were technical problems, especially when the students tried to rewind or forward a recorded video during a real-time session. The individual presentation was in real-time. Sometimes recorded video was presented in a real-time session.

The academic developer regarded the concept of Elluminate as similar to older technologies. *"The idea or concept of Elluminate is not new" (Academic Developer Case 2).* The pedagogical concepts relating to Elluminate lecture delivery were not new as the affordances enabled one-to-many lecturer-student transfer of information. However, students could interrupt and ask questions in real-time where earlier Web 1.0 technologies were restricted to text-based questions in real-time and recorded video delivery. The impact on students' preparedness to ask questions when they are not in a traditional lecture theatre with many others has not been investigated by this study but interaction levels may be improved (Ullrich et al 2008).

The university, in this case, implemented Elluminate due to the availability of a stable infrastructure that enabled interaction with minimal technical problems. *"We have been waiting really for a software and the technology to come closer together to make it possible for the idea of all things you can do in Elluminate"* (Academic Developer Case 2). As the university increased bandwidth it became feasible to use Elluminate, as the performance of the IT infrastructure and evidence of increased robustness and reliability of the software impacted on academic decisions to use Elluminate, as *"the ability of the software to use the available bandwidth between computers, so the connection speed has been very much a factor in the success of the software and its ability today" (*Academic Developer Case 2). The infrastructure impacted on ease-of-use for the stakeholder groups.

The lecturer stated that Elluminate was used for lecturing students in another country at an off-shore campus. He suggested that *"to make the learning a success, there should be a day when all the students get together for training and getting to know the digital identity of peers. This could make a huge difference to the value of the subject as everyone would feel they were part of the subject"* (Lecturer Case 2). The lecturer compared Elluminate with e-mail and bulletin boards and, like the lecturer in Case 1, found the Web 2.0 interactive affordances superior to the Web 1.0 communication in text.

The Project Management lecturer had experience in using Elluminate breakout-rooms that facilitated students completing team-based activities. The organisation of Elluminate break-out virtual spaces mirrored the organisation of activities and students in traditional face-to-face spaces. The students were able to conduct group discussions to complete assignments. Then they came back together to the virtual main room or platform in the web session to present their group work to lecturer and peers.

The academic developer suggested that Elluminate was suitable for small groups and synchronous distance learning, because real-time collaboration and interaction could be achieved. *"Elluminate is used for small group and distance synchronous learning that means it is in real time. So if I am moderating now, everybody has to be there"* (Academic Developer Case 2). Elluminate can also be used for tutorial groups at a set time irrespective of the time zones of the geographical locations of the participants.

4.4.8 Case 2 Business – Conceptual Model

Based on Elluminate affordances implementations in Case 2, a business subject, several themes were identified in each domain of the research conceptual model. The Elluminate affordances used in Case 2 were screen-board, text, audio, emoticons and polling. In Solution Technology Invention, technical constraints prevented the lecturer from using Elluminate in the current situation. The learning constraints included the inability to meet face to face and see the non-verbal communication through the body language of the students in class, and the inability to project the lecturer's personal charisma. The number of students in a web session was small and that enabled presentations through Elluminate by the students. Small breaks were needed for a long web session for the lecturer and students to refocus and reconcentrate in the next session to mitigate stress. In Naturalistic Evaluation, the affordances were useful to present and provide lectures to off-shore students. Although there were many affordances, training was not required by the lecturer and students. It was easy to use. The lecturer did provide a practice session early in the semester to familiarise students with the affordances used in the web session. In Theory Building, the students were expected to present their discussion through Elluminate to other students where it was assessed. The necessity for

constructional alignment principles to underpin the design of a subject was the same as Case 1. The subject evaluated was designed in this way.

Table 4.4 describes the seven affordances (screen-board, text, emoticons, audio, video, polling and recording) used in Case 2 Business and the level of interaction and group size.

Table 4.4: Summary of web interactive multimedia technology affordances for learning in Case 2

Affordances	Small groups	Lecturing (Low interaction)	Discussion (High interaction)
Screen-board	☒	☒	-
Text	☒	☒	☒
Emoticons	☒	☒	-
Audio	☒	☒	☒
Video	-	-	-
Polling	☒	☒	-
Recording	☒	☒	-

Based on the analysis and evaluation of Case 2, Elluminate was used with a small group of students for lecturing and student presentations. Discussion was undertaken within the group of students, using the virtual break-out room. The interaction did not require lecturer intervention or facilitation. The lecturer found the use of this virtual environment to be effective as the students met assessment requirements in the same way as the traditional group. The screen-board was suitable for a small group and for lecturing activity which involved low levels of interaction. Text was suitable for a small group of students for lecturing and discussion with both low and high levels of interaction. Emoticons were suitable for a small group of students for lecturing with a low level of interaction activity. *"That would be pretty useful...for small groups for things like that"* (Lecturer Case 2). Audio was suitable for a small group of students for lecturing and discussion activities in both low and high levels of interaction. Video was suitable for a small group of students but only recorded video was used, not video using web-cam in this case. Polling was suitable for a small group of students

and for lecturing with a low level of interaction. Recording had the potential for students' use for revision later, for students who were absent, or for re-use in the subject the following semester.

4.5 A Foundation Computing Subject (Case 3)

The subject was called Business in Computing (BCPF01[4]) and was taught as part of a foundation subject. The subject was designed to provide students with fundamental knowledge and skills needed over a broad range of business computing topics in preparation for learning at the higher education level. It began by introducing students to the concepts and theories that underpinned the operation of computers, particularly the personal computer. Students were taught starting from the basic computer concepts with an emphasis on the personal computer and its practical use, including computer hardware, software, the internet and World Wide Web, networks, e-commerce and database management systems. In addition, students developed the skills needed to create text documents and presentation slides, to manipulate and analyse data using spreadsheets, and to organise and retrieve data using a database. The subject comprised two main modules: computer concepts and hands-on personal computer skills to develop a deeper understanding of the various software applications which run in parallel mode throughout the semester.

4.5.1 Case 3 Computing - Learning Environment

The subject was taught to on-campus students. The subject was only offered in the normal physical classroom sessions and laboratory sessions. However, Elluminate was used for

[4] Business Computing Subject Guide

consultation, during laboratory sessions and for revision before the final exam. The affordances used in each session depended upon the activities that were conducted.

4.5.2 Case 3 Computing - Student Class Size

The number of students in a classroom was approximately thirty-five students. When using Elluminate, the total number of students in a session varied since Elluminate was used for three purposes, as follows:

- Consultation for assignments (involving from one to five students);
- Demonstration during each laboratory session (there were twenty to thirty five students, which was the maximum number in a class);
- Revision sessions that were held at the end of the semester before the examination week (the number of students ranged from fifteen to twenty-five).

4.5.3 Case 3 Computing - Why Elluminate?

Elluminate was chosen by the subject coordinator who was also the lecturer, to expose the students to an emerging technology. A survey was conducted by the lecturer to obtain student feedback about using Elluminate. The lecturer found that the students' felt the technology provided advantages when compared to a traditional class. They did not have travel to campus and they could obtain immediate feedback when problems arose whilst they were completing learning activities through the web. The students were motivated to attend the revision sessions and sometimes attended more than one. The revision sessions were held a week before the final exam.

4.5.4 Case 3 Computing - Solution Technology Invention: Delivery Strategies and Constraints

Elluminate was used as a tool for laboratory, revision and consulting sessions. During the laboratory sessions the students could see the lecturer's desktop reflected on their own desktop, due to the use of the screen-board. The students did not have to walk to the front of the class. They could follow the steps shown by the lecturer on their own desktop at their own desk. Revision sessions where students could get together in the comfort of their own home, during the study week before the final exam, were useful for exam preparation. Normally, before a revision session started, a practice session was open so that students could set up Elluminate and ensure that there were no problems with their personal computers. The students who did not participate in the practice session often faced problems logging into the sessions. To reduce the impact of technical compatibility problems for the students accessing Elluminate offsite the lecturer opened a consultation session several days before the assignment submission date.

The lecturer limited the affordances used, although he knew from professional development Elluminate workshop sessions that he had attended that there were other options that could have been utilised. The subject was also delivered by other lecturers. The lecturer, who is also the subject coordinator, wanted to enable consistency across all deliveries of the subject irrespective of the lecturer delivering each class. The level of interactivity for each laboratory class and for each student had to be equitable. Interaction opportunities were provided to all students whether they attended the lecturer's sessions or those of other lecturers. The lecturing materials such as MS PowerPoint slides of this subject with many lecturers were the same.

The subject guide stated that lectures, tutorials, computer laboratory practicals, field trips (optional) and independent study were the learning activities to be delivered. Only revision for final exam sessions, consultation sessions and computer laboratory practicals were covered through Elluminate.

Elluminate was used in a computer laboratory to demonstrate to the students how to use features and functions of Microsoft Office applications such as MS Excel. The lecturer displayed the MS PowerPoint slides at the front of the class during a computer laboratory session. The students could see the steps taken by the lecturer through Elluminate on their own computer screen. Students learnt to use Elluminate during a guided session at the start of the subject delivery. They then had opportunities to implement the skills learnt during each computer laboratory session.

According to the lecturer, about fourteen students normally attended each web session. The lecturer prepared slides consisting of questions for the students to answer and discuss during the real-time web session. *"The students were allowed to type (using text affordance). Sometimes multiple choice questions (using) polling with A, B, C, D and the chat room (text affordance were used). The students were allowed to talk but they do not like to talk (using the audio affordance)"* (Lecturer Case 3). During the revision session on Elluminate, the *"students could contribute and scribble on screen-board, we want them to do that"* (Lecturer Case 3).The students were provided opportunities to volunteer to write their solutions to presented questions on the screen-board. The volunteer used the pen on the screen-board. In Case 3, the screen-board was used for media sharing in a laboratory during discussions In the laboratory session, the screen-board was used to lock the students' monitors and display what the lecturer was doing so that students could watch the steps used to complete or obtain a

process. As the lecturer commented *"I shared MS* E*xcel with them* (*the students) and gave them instructions. They did not have to come to the front as they did it in their personal computer using application sharing"* (Lecturer Case 3).

In the discussion-like environment, the screen-board was used interactively where questions were displayed and at least one student scribbled answers. Innovation and change were apparent as the approach had moved from a traditional to an enhanced interaction. In Case 3, text was only used by the students as the lecturer chose to respond using audio. The lecturer stressed that it was crucial to limit the number of students who could respond or ask questions at the same time. The lecturer's ability to handle students' feedback was affected by the number of students. The lecturer made a pedagogic decision whilst planning learning activities to control the number of students as it was *"hard to control twenty five students asking and typing questions"* (Lecturer Case 3). The screen-board, text or audio were used to provide text or audio explanations or solutions. In Case 3 the audio was used in the discussion session for interaction between the lecturer and students. However students preferred to use text rather than audio. *"Students could ask also in audio (but) they did not feel comfortable. They prefer text although most of them have microphone when ask to raise their hands those who have microphone"* (Lecturer Case 3).In Case 3 the emoticons were used by the lecturer to get a response from the students. The lecturer would prompt the students by saying, *"Raise hand if you can hear me"* (Lecturer Case 3).

Screen-board was the only affordance used during the computer laboratory practical activity session because the laboratory was conducted in a traditional physical space with the lecturer and students in the room at the same time. The lecturer used the screen-board to demonstrate the use of features of the technology to students prior to their individual practice activities, for

example, the steps to accomplish a task in MS Excel. The lecturer did not have to use the audio affordance as the lecturer spoke directly to the students in the traditional face-to-face laboratory environment. The students could watch the lecturer's mouse movements, clicks and typing on their own monitor, on their desk.

Screen-board, text, emoticons, audio, polling and recording affordances were used for revision and consultation sessions during web-based sessions. The revision and consultation sessions were conducted virtually. In the revision session, the slides were designed to contain questions for student practice. Selected or volunteer students wrote their solutions on the screen-board first to facilitate discussion. In the consultation session, the lecturer would wait in his office for students to login to Elluminate and ask questions regarding assignments and the exam. The Elluminate affordances recommended for use according to requisite interaction levels and the number of students in the learning activity group are summarised in Table 4.5.

Table 4.5: Summary of Elluminate affordances used in learning and teaching activities in Case 3

Technology affordances	Laboratory	Revision
Screen-board	☒	☒
Text	-	☒
Emoticons	-	☒
Audio	-	☒
Video	-	-
Polling	-	☒
Recording	-	☒

For revision and consultation sessions, the affordances recommended were screen-board, text, audio, emoticons, polling and recording. For computer laboratory practical sessions, the affordances recommended were screen-board.

4.5.5 Case 3 Computing - Naturalistic Evaluation: Stakeholders Evaluation

The lecturer was very impressed with Elluminate and would like to expose students to the technology in a larger variety of learning environments. "*As (the subject) coordinator, I would love to use Elluminate and other few technologies for students*" (Lecturer Case 3). In the lecturer's opinion, Elluminate was not for just useful for one type of subject but could be used for any subjects in a variety of ways. Once a lecturer had designed learning or assessments activities, the appropriate affordance could be identified, planned and used. Elluminate was *"used not because of the nature of the subject"* (Lecturer Case 3). The lecturer shared the experience of using Elluminate with colleagues responsible for other subjects, such as, marketing and management information systems. The web-based multimedia affordances of Elluminate were used to conduct revision sessions using, previous year essay exam questions, instructions on how to write essays and sharing and discussing solutions on the screen-board.

The lecturer had used Elluminate for teaching the computing subject, as well as marketing for postgraduate students. Although the activities conducted for undergraduate foundation studies and postgraduate marketing were different, the technology could assist in preparing students for the final exam and enhance their understanding of the subject.

4.5.6 Case 3 Computing - Theory Building: Learning Constructive Alignment

The subject was designed with the learning activities and assessments evidencing alignment with achievement of the specified intended learning outcomes, which follows constructive alignment principles (Biggs 1996; Biggs & Tang 2007). Evidence of constructional alignment

underpinning the subject design and the scheduling of learning activities and assessment in the Computing subject is shown in Figure4.4.

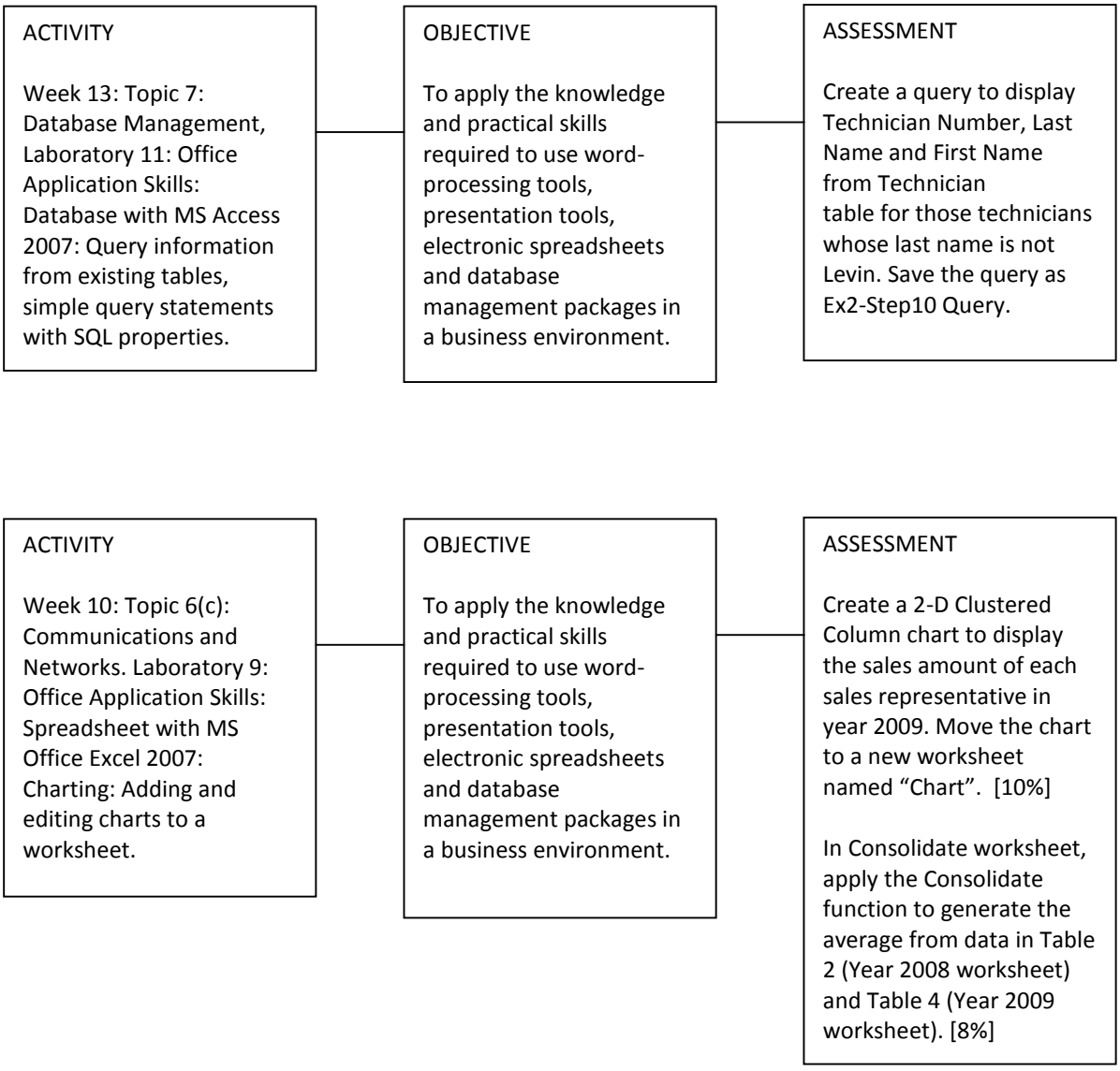

Figure4.4: Case 3 Computing -Aligning learning activities and assessment to intended learning outcome

4.5.7 Case 3 Computing - Web Interactive Multimedia Technology in learning

Elluminate was used in laboratory, revision and consultation sessions. In laboratory sessions, the lecturer used desktop sharing where students could see what the lecturer was doing (e.g., on MS Excel). For revision sessions, a high level of interaction was needed. MS PowerPoint

slides were used with questions and blank spaces for students to provide input and write on the screen-board. Students were usually at home, which was convenient as they sit in their house without travelling to class, when they participated in this activity. The audio affordance was enabled and it was compulsory for the students to have headsets. There was a maximum of twenty-five students in a session. Attendance was high because students would attend more than one revision session because it was close to the final exam. For consultation sessions, the students were given an opportunity to get in touch with the lecturer through Elluminate before assignments were due. The students had the opportunity to ask questions and share problems.

During the revision sessions, classroom management steps were taken as the affordances were managed by the lecturer. This was important for a small group of students and critical for a large number of students. *"We allow them to use pen and we have to control, only one person to write (at a time), not permission to whole class. In less than ten seconds the slide can be full* with *their answers if we give them all permission to write"* (Lecturer Case 3). Elluminate was used for more than one type of planned learning session. Based on the objectives that the lecturer wanted to achieve, the affordance to be used was aligned with planned learning activities. For example, the desktop sharing and the screen-board were used to enable the lecturer to demonstrate technical application use. The students were required to submit video assignments and use discussion forums on Blackboard, not on Elluminate. The students were allowed to talk one at a time during revisions sessions.

4.5.8 Case 3 Computing – Conceptual Model

A conceptual model was developed based on the Case 3 interview transcripts and document analysis. Based on Elluminate implementation in Case 3, a computing subject, several themes

were identified in the Solution Technology Invention domain. Screen-board was useful for a larger group in a traditional setting. Audio and the screen-board were useful for revision and consultation in smaller groups where high interaction was required. A small group, as seen in the revision session, was important for a high interactivity session where students had the opportunity to provide feedback for the lecturer to comment on. The affordances enabled needed to be limited to mitigate the technical constraints. In Naturalistic Evaluation, each affordance was easy to use. The lecturer and students did not require training. The lecturer had some professional development and understood how to use a range of affordances. He got a lot of staff and students to use a limited range of affordances successfully. He taught the students how to use Elluminate. The affordances were useful to the lecturer. The screen-board was useful to display the MS PowerPoint slides and receive feedback from the students, audio was useful for the lecturer to present and provide responses to students and recording was useful for future use by the students. In Theory Building, the subject was found to be well designed. The lecturer believed that Elluminate could be used for any subject taught.

Table 4.6 describes the seven affordances (screen-board, text, emoticons, audio, video, polling and recording) used in Case 2 and the level of interaction and group size.

Table 4.6: Summary of web interactive multimedia technology affordances for learning in Case 3

Affordances	Large group	Small group	Laboratory (Low interaction)	Revision (High interaction)
Screen-board	☒	☒	☒	☒
Text	☒	☒	-	☒
Emoticons	☒	☒	-	☒
Audio	☒	☒	-	☒
Video	-	-	-	-
Polling	☒	☒	-	☒
Recording	☒	☒	☒	☒

In Case 3, Elluminate was used with a large number of students in laboratory sessions and a small number of students in revision sessions. Based on the analysis and evaluation of Case 3,

the screen-board and recording were suitable for both large and small groups of students and for both laboratory and revision activities which involved both low and high levels of interaction. Text, emoticons, audio and polling affordances were suitable for large and small groups of students for a high level of interaction. Video would have been suitable for a small group of students as the group size was small but it was not used in this case. Recording was for students' future use and the revision sessions were appreciated by the students preparing for their final exam.

4.6 A Postgraduate Consultancy Subject (Case 4)

The subject was called Professional Lactation Consultancy (OHTH2143[5]) and was taught as part of a postgraduate program in advanced lactation consultancy. The aim of the subject was to provide the students an opportunity to build on knowledge gained in Breastfeeding and Human Lactation subjects by developing students' understanding of complex breastfeeding and human lactation issues. The subject focused on the advanced professional and clinical practices which enable students to address the needs of breastfeeding mothers and their babies with complex care requirements.

4.6.1 Case 4 Lactation Consultancy - Learning Environment

The subject was taught to off-campus students. The class was usually conducted once a fortnight for approximately two hours. The students undertook weekly modules prepared by the lecturer. There was a high component of independent learning. The students were expected to do self-directed learning based on the subject weekly modules and targeted

[5] Advanced Lactation Consultancy Subject Guide

objectives. The same method of delivery was used for another three subjects in the graduate program. The affordances used were text for complementing audio problems, emoticons for expressing agreement and disagreement, and audio for discussion.

4.6.2 Case 4 Lactation Consultancy - Student Class Size

In online sessions up to ten students used Elluminate for their classes, although the total number of registered students was more than that. Students came from all over Australia and overseas.

4.6.3 Case 4 Lactation Consultancy - Why Elluminate?

Elluminate was chosen as the tool for communicating with the distance students as the programme was for professional health working staff that registered as off campus students. The lecturer had been involved in a pilot study for Elluminate. An academic developer trained volunteer lecturers involved in a pilot study whilst managing facilitated group sessions. The students in the lactation consultancy subjects were working practically in the clinical area. They meet together in a web session where they shared their experiences, problems and solutions.

4.6.4 Case 4 Lactation Consultancy - Solution Technology Invention: Delivery Strategies and Constraints

Elluminate was used as a discussion tool for the distance education students. The main affordance used was audio, as a medium for student's to discuss and share experiences of

their clinical work. There were a lot of technical and operational problems encountered using the audio affordance. *"Sometimes it is a nightmare … Whooshing sound and echo … Although use headset … Ghostly sounds"* (Students Case 4). In Case 4, the screen-board was not used interactively and sometimes not used at all. It was used for presenting lecture slides or writing questions early in the semester. Sessions later in the semester used audio to facilitate discussions. *"Occasionally, the lecturer wrote on the screen-board or showed us DVDs to illustrate something. We also did exam practice with questions written on the screen-board"* (Student Case 4). In Case 4, the text was mainly used by the students as the lecturer would respond in audio. The lecturer pointed out that the students especially the *"younger ones"* preferred to use *"text speech"* rather than speaking English. *"This was mainly used when discussing projects or facing audio failure"* (Lecturer Case 4). Text was preferred by the students during discussion and when facing audio technical problems as text enabled the students to communicate to the others in the web session. In Case 4, the audio was used for interaction between lecturer and students. The lecturer only enabled three simultaneous speakers. Having more than three speakers was *"difficult to manage"* (Lecturer Case 2). The lecturers in most cases limited the speakers to only three at a time for managing the discussion and mitigating the technical constraints or noises. Classroom management issues were identified relating to large numbers of students. In fact three students would not be considered a viable class size in many higher education institutions. In Case 4, the emoticons were used by the lecturer to get the students feedback. *"I can see very clearly who wanted to ask the question first"* as the lecturer highlighted the use of the hand-up (Lecturer Case 4). Using the 'hand-up' emoticon, with the associated ascending number displayed beside the students name in the profile window, the lecturer could interact with students in the appropriate order by following the displayed number on the 'hands-up' icon.

The learning activity where the lecturer facilitated open discussion was conducted using Elluminate. In the open discussion, the microphone that enabled audio affordance was limited by the lecturer to mitigate technical problems. *"I set it for three speakers at once. I can usually organise them fairly well"* (Lecturer Case 4).

Due to the people and technical constraints, the lecturer enabled three speakers at a time. The students found that they needed to take turns responding to questions and contributing to discussions. "*When the lecturer limited the speakers to three at a time and the student tried to get an opportunity to speak (by attracting the lecturer attraction) using the hand-up emoticon"* (Student Case 4). The student also stated that in a different session where maximum speakers were enabled, the technology worked well but the organisation of the class felt chaotic.

The Elluminate affordances used in learning activities in Case 1and the environments where the stakeholder's ascertained that they were useful are summarised in Table 4.7. Five Elluminate affordances were used in Case 4, for discussion activity sessions on the web. The affordances recommended were screen-board, text, audio, polling and recording. Recording was recommended for viewing lecture-style learning activities for students who did not attend the real-time lecture web session.

Table 4.7: Summary of Elluminate affordances used in learning and teaching activities in Case 4

Technology affordances	Discussion
Screen-board	☒
Text	☒
Image (Emoticon)	-
Audio	☒
Video	-
Polling	☒
Recording	☒

4.6.5 Case 4 Lactation Consultancy - Naturalistic Evaluation - Stakeholders Evaluation

The lecturer and students appreciated the ability to get together and discuss important issues to improve their clinical practice, even though they faced some technical issues. The students highlighted the usefulness of Elluminate. *"Look at other people … to get professional kind of opinion … enjoy Elluminate session"* (Students Case 4). Some faced the problems on the web session positively, as illustrated by a student *"Technology problems side of things is minor compared to what I get from Elluminate session"* (Students Case 4) and some negatively *"frustrating… time consuming … It is broken sometimes … takes up to twenty minutes to sort out technology taking out from our precious web session time. Then in the evening we were tired and we have got to go to work again"* (Students Case 4).

The subject focused on the students' reflections of experience rather than delivering the knowledge and skills content of the subject. Elluminate was used to bring students together to enable discussion. *"Largely getting group together to talk about what's going on*" (Lecturer Case 4). The students found it beneficial for their study as Elluminate enabled discussions in a virtual classroom in almost real time manner. Elluminate, was used for learning activities for graduate students. "*Being able to talk to everyone important to collegial and communicate to each other. I have talk through e-mail and by phone as well but that does not allow the group to get together*" (Student Case 4). Elluminate accommodates one-to-one communication and groups of students small and big number of students. *"I will put up a question and give them three or four alternatives and they need to answer"* (Lecturer Case 4). The lecturer used the polling affordance to assess the students or to get the students' attention.

The lecturer found Elluminate useful for having a guest speaker in a web session, as well as for discussion between students. *"The guest speakers are sitting at their desk at home. They just login like students login with moderator privileges"* (Lecturer Case 4). Then the lecturer could use the recording of the guest speaker for future sessions. The students could also access the recording of the web session at any time if they did not attend the original real web sessions. In this case, recording was mentioned in a rather positive way as no technical problems were highlighted, like those highlighted in Case 2. Recording in Case 2 suffered from technology infrastructure download problems. In Case 4, the recording of the previous guest speaker in Elluminate session was used in the following semester.

4.6.6 Case 4 Lactation Consultancy - Theory Building: Learning Constructive Alignment

The subject was designed so that the learning activities and assessment enabled the students to achieve the intended learning objectives (Biggs 1996; Biggs & Tang 2007). Figure 4.5 maps a sample of the intended learning objectives, learning and teaching activities and assessment methods, based on the evaluation of the subject guide and assessment documents of the lactation consultancy subject.

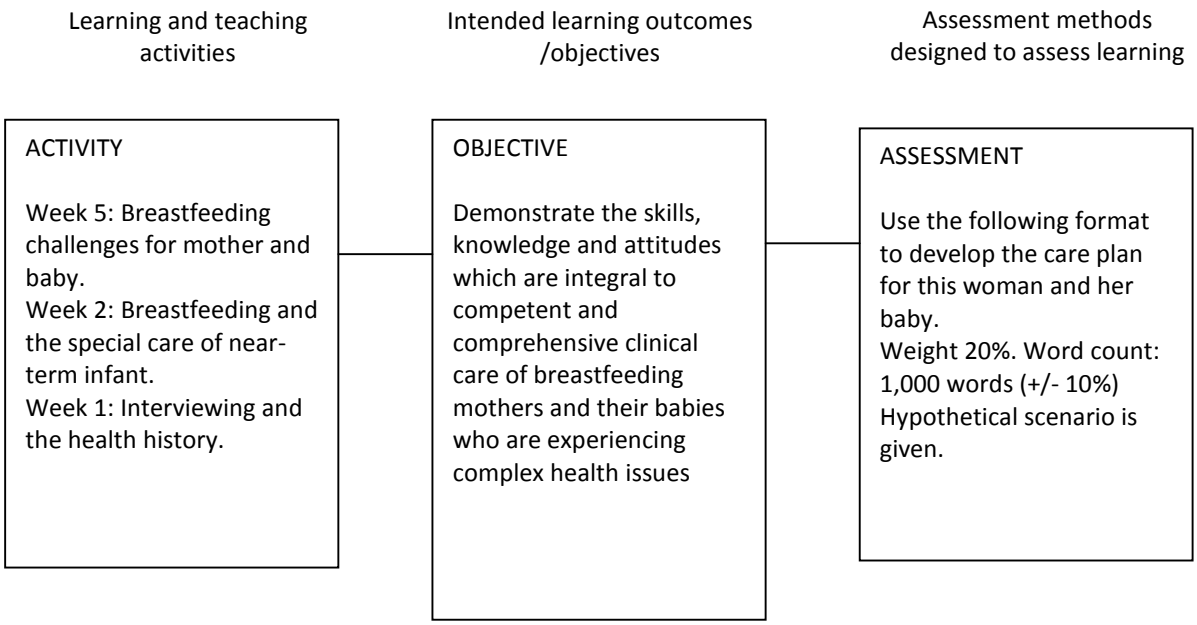

Figure 4.5: Case 4 Consultancy - Aligning learning activities and assessment to intended learning outcomes or objectives

Figure 4.5 illustrates the alignments of the assessment tasks that were provided as an assignment in the subject and the learning activity scheduled for the week to ensure the demonstration of requisite skills, knowledge and attitudes. All activities and assessments were integral to the development of competent and comprehensive clinical care of breastfeeding mothers and their babies, who were experiencing complex health issues. The activities planned for weeks 1, 2 and 5 were designed to support the development of the specified learning objectives.

4.6.7 Case 4 Lactation Consultancy - Web Interactive Multimedia Technology in Learning

This section looks at the technical and environmental constraints to Elluminate affordances used to support learning and teaching. In this case, discussion was the main activity for which Elluminate affordances were used. From observation, the lecturer was an excellent facilitator

and provided timely instructions to organise group discussions. Students learnt to use the smiley face emoticon to signal they wanted a turn to use the audio.

In web classes, the lecturer did not have non-verbal feedback from students as normally visible in physical classes. Visual cues such as facial expressions were absent from the learning and teaching environment. The lecturer could not tell if the students were falling asleep which would normally be a strong signal for activity change. "*When teaching in front of the classroom, you can see the students, you can see the ones who are going to sleep...just keep prodding them when you are using Elluminate*" (Lecturer Case 4). The group was small and the lecturer could conduct the web class session from her home at night. Classes in the evening were convenient for students who were often working during office hours and available afterwards.

The students usually used text rather than audio, and this sometimes did not provide the lecturer with a sense of the students' current level or stage of understanding the delivered material. "*(I prefer) audio...at least get an idea where you are at. If you just get in the text, particularly the younger ones, they use text speech rather than English*" (Lecturer Case 4). The sessions were tutorial style sessions where the students had the opportunity to state what they had learnt whilst completing the assessment task. It was important to them to be collegial and communicate with each other "*to get professional kind of opinion*" (Student Case 4). In the web sessions, the lecturer acted as a facilitator managing and directing discussions. A student suggested having more communication between students rather than just being lecturer led. "*The only thing missing is the participation between students*" (Student Case 4). In this case, the lecturer was the facilitator, most of the time and would answer the students'

queries. The student proposed to have more student-student discussion time provided by the lecturer during each web session.

4.6.8 Case 4 Lactation Consultancy – Conceptual Model

A conceptual model was developed based on the Case 4 analysis of the interview transcriptions and subject documents. The Elluminate affordances used in Case 4 were screen-board, text, audio, emoticons, polling and recording. Several themes emerged in each domain of the research conceptual model. In the Solution Technology Invention domain, the main learning constraint was the lack of peer discussion. Time wasted in solving the technical constraints was frustrating to the students. The number of students in a particular session was small. Emoticons were important as non-verbal communication such as body language was not apparent to the lecturer. There was a need to minimise the affordances enabled to mitigate the technical constraints. There was a need to facilitate conversation. The process was a traditionally designed and delivered subject using modern web-based multimedia technology affordances. In Naturalistic Evaluation, the themes that emerged were the ability to conduct discussions in the evening and the convenience of the group being located outside traditional classrooms for students working during office hours. Training was not required for the students to learn to use the screen-board. They were a little shy of using the audio affordance and would revert to text if possible. However the smiley face emoticon was a useful device for signalling a desire to speak during discussions. In Theory Building there was a need to move from assessment of learning to assessment for learning (Attwell 2010).

Not all of the affordances were used at once. In Case 4, Elluminate was used with a small group of students for discussion between the lecturer and students. Based on the analysis and

evaluation of Case 4, the screen-board, text, emoticons and audio affordances are suitable for small groups of students and for discussion activity which involves high levels of interaction. Video was not used in Case 4. The use of each affordance and the associated group size and interaction levels are illustrated in Table 4.8.

Table 4.8: Summary of web interactive multimedia technology affordances for learning in Case 4

Affordances	Small group	Discussion (High interaction)
Screen-board	☒	☒
Text	☒	☒
Emoticons	☒	☒
Audio	☒	☒
Video	-	-
Polling	☒	☒
Recording	☒	☒

4.7 Web Interactive Multimedia Technology in Subjects Stakeholders' Analysis

The relationships between the stakeholders are important for successful implementation of the affordances to support learning and teaching activities. The academic developers involved in the actual implementation at the university-wide level supported lecturers during the Elluminate implementation phase. The academic developers were encouraged to work together with the lecturer to explore the best way to use the system to augment the delivery of activities and assessment tasks. Lecturers then supported students learning to use the emerging technology. Figure 4.7 illustrates the requisite relationships between stakeholders and the various roles of the stakeholder groups.

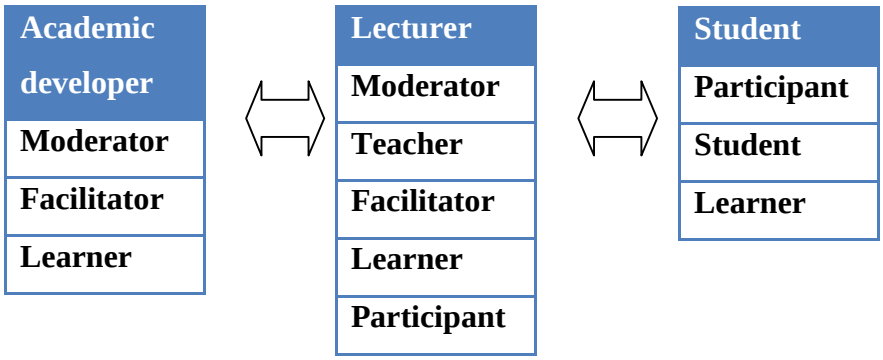

Figure 4.6: Stakeholders' relationships

Analysis of interview transcripts indicated that the academic developers supported lecturers learning to use Elluminate to achieve the learning goals and objectives in their subjects. A lecturer could then use Elluminate affordances to teach students. Several terms were used to describe the stakeholders. The academic developers used the terms "moderator" and "participant". The moderator had the ability to grant and disable certain affordances, thus controlling and managing the web sessions for the participants, who were the students. Academic developers became the trainers as they supported the lecturers to learn. The academic developers and lecturers experimented together to identify the best way to achieve subject intended learning objectives. In order to operate as a staff trainer or facilitator, the academic developers attended organised web sessions to increase their own understanding and to experience the learning environment as a learner.

4.7.1 Solution Technology Invention – Delivery Strategies and Constraints

In this section, the use of Elluminate affordances in the four subjects is discussed based on the themes identified in the Solution Technology Invention, Naturalistic Evaluation and Theory Building domains of the research conceptual model (Table 4.9).

Table 4.9: Identified themes from interviews

Domain	Affordance	Themes
Solution Technology Invention	Screen-board	Desk sharing useful in large groups for information dissemination Text-based interaction facilitated in small groups. This type of activity often also used audio.
	Text	Chat was used to facilitate questions and answers. This affordance was common to a number of available technologies, e.g., Web 1.0 Learning Management Systems.
	Emoticons	Useful to signal intentions to join a discussion by students and as a class management tool by staff conducting discussions where large numbers of students were allowed to speak.
	Audio	Facilitated discussions in small groups. Server capability and broadband bandwidth are the major constraints.
	Video	Used to allow recognition of student. Technical download constraints. Applications such as Skype used for peer discussions outside class. Provides non-verbal physical cues to attitude. Server capability and broadband bandwidth are the major constraints.
	Polling	Commonly used with large groups to provide the lecturer with an understanding of students' understanding of delivered knowledge. Lecture style activities.
	Recording	Useful for students who could not be present at the scheduled lecture time
	Technical constraints	The used of web technology was effected by the bandwidth of the network infrastructure, compatibility of the application with the existing infrastructure. Video can run smoothly and at most hang the system. Team communication was important to make sure all parties involved especially the technical support team and prepared to provide the needed support. Audio not robust in terms of sound quality. Time to log in took a lot of the precious time during odd hours.
	Learning constraints	Time, small group sessions, physical or non-verbal communication, limiting the affordances enabled, facilitating conversation and needing breaks in lecture presentation in the forms of discussion or interactions.
Naturalistic Evaluation	Useful for learning	Polling was used in large groups of students. Audio was used for lecturing Emoticons was used for classroom management Screen-board was used for presenting slides or images or demonstrating, Text was important for asking questions and as substitute to audio problems Video was used for small group, demonstration, guest speaker presenting Recording was important session for further watching or review
	Easy-to-use	Training was not required for the use of audio and chat No-one stated that the affordances were difficult to use as a constraint to usage
	Attitude in facing problems	Both positive and negative
Theory Building	Meeting the intended learning objectives	All cases well designed using constructional alignment principles
	Implementing web interactive multimedia technology affordances in learning activities and assessment	Affordances were chosen to augment delivery of learning activities and assessments. The modes of delivery were conducted in several ways by the lecturers. Some lecturers used the affordances to deliver the subject similar to the normal physical class. Some lecturers changed the mode of delivery on the web. The students demanded change in mode of delivery.

Seven affordances were used in the actual learning and teaching environments. The seven affordances were screen-board, text, audio, emoticons, video, polling and recording. According to the transcripts of the interviews with the stakeholders, the screen-board had many features that were used. These were: navigation tools such as next, previous, first and last; arrow pointer; pen; highlighter; eraser; text; basic shapes and drawing shapes such as circle, square and line. The affordances were for pointing to hotspots. The pointer was used to highlight images on MSPowerPoint slides that were shared with the students. MS PowerPoint slide presentations were used by the lecturers to present materials to the students. The screen-board was also used as a blank screen to write co-author text. Academic developers mentioned the ability to jump to a specific slide in a MSPowerPoint presentation, to facilitate a question and answer session.

The technical constraints in using Elluminate were found to be infrastructure, team communication, audio and time to log in. Although there was advancement in the organisational infrastructure, the application was not free from problems. Many of the stakeholders faced technical problems when using Elluminate. In order to support these stakeholders and mitigate technical constraints, team communication was found to be important, especially in the front line, which should also be included in any pilot study for adopting emerging technologies. The audio was found to have major technical constraints as lecturers mainly used audio to conduct lectures and respond to students' feedback. Although the academic developers and lecturers mentioned that the use of headsets could mitigate the problem, there were still instances of students who did not use them. Some students commented that although they used headsets, there were still audio problems such as background noise. Time to log in was also a technical constraint, as this was considered as wasting time and could leave the students behind in real-time learning sessions on Elluminate.

The learning constraints in using Elluminate were found to be: session time, group size, lack of physical or non-verbal communication, limiting the affordances enabled, facilitating conversation effectively and needing breaks in lecture presentation in the forms of discussion or interactions. Time was found to be a learning constraint with Ellluminate sessions kept short as intense concentration was required during sessions. Elluminate was found particularly useful for small group sessions, where it was manageable and was less constrained by technical problems. Physical or non-verbal expression was also a constraint to learning as physical expressions such as body language and natural facial expressions were not available when using Elluminate affordances. Some lecturers would prefer to project their personality in a face-to-face class with the students during the lecturing session to impart the knowledge to the students.

Limiting the affordances was a managing strategy used to mitigate the technical problems, reduce training needs and ease the transition to a new learning and teaching environment for staff. Facilitating conversations was found to be a learning constraint in some classes as lecturers and students did not have normal physical cues, to inform them about who should speak next. Students had to rely on the lecturer to facilitate conversation or pass the microphone. As a session in Elluminate was considered intense, breaks were needed to facilitate the students' concentration on the knowledge delivered through the monitor.

4.7.2 Naturalistic Evaluation – Stakeholders' Evaluation

Stakeholders' perceptions of the ease-of-use and usefulness of the affordances in the higher education context were evaluated. Each case study was analysed against the conceptual model and a final model was constructed. Using soft system methodology, it was apparent that stakeholders were in agreement about the usefulness of Elluminate affordances for learning and the affordances were easy-to-use. Elluminate was found to be better than the system that had been used previously, as it contained more than one affordance to be used for interaction in low or high interaction classes with small or large numbers of students. Often more than one affordance was used simultaneouslynas one affordance cover the visual and another affordance cover the audio.

When using the affordances, technical problems were found to exist, and attitudes in facing those problems were important to the adoption of Elluminate for learning. With a positive attitude, the stakeholders would put effort into providing a solution or a work-around option to achieve a smooth web session for learning activities. A negative attitude would hinder the stakeholders from using the affordances in the future.

4.7.3 Theory Building – Learning Constructive Alignment

Each case was checked against constructional alignment to examine the subject design was following its principles. Theory Building was also used as a scope for this research to choose appropriate case studies. The subjects in the case studies were found to be designed in accordance with Biggs's (1996) and Biggs and Tang's (2007) constructional alignment

principles. Students were given the subject guide early in the semester and needed to construct their own learning in order to achieve the stated learning objectives of the subject.

4.8 Summary

This chapter has presented the findings from the interviews on the responses and experiences of the stakeholders – academic developers, lecturers and students – in using Elluminate in subjects in higher education institutions. The views of the stakeholders were compared in each subject as a case study analysis, where the findings indicated that similar issues were discussed in each subject in Solution Technology Invention, Naturalistic Evaluation and Theory Building domains. It was found that seven affordances were commonly used: screen-board for lectures, discussions and exercises during the web sessions; text in the lectures and discussions; emoticons in lectures, discussions and exercises in the web sessions activities; audio in lectures and discussions activities; video in lectures and discussions activities; polling in exercises during the web sessions to get feedback from the students or to test their understanding and to gain their attention; and recording for future use by the students or the lecturer. The constraints were evaluated based on stakeholder analysis. Elluminate was found to be useful for learning, was easy-to-use and had many affordances, which were considered by the stakeholdersbetter than using only one affordance or a traditional learning and teaching delivery. Attitudes in facing problems when using Elluminate were found to be important as they could hinder the learning activities that were planned to be implemented during the web sessions. The use of Biggs' (1996) and Biggs and Tang's (2007) constructive alignment principle at the design stage of a subject was found to be useful as the lecturers were well prepared and the students' expectations were moulded appropriately. It was also found that Elluminate could be used for learning activities as well as assessments tasks during web

sessions. A detailed discussion of the findings in the context of the initial conceptual research framework and theory is presented in the next chapter.

5 Discussion

Based on the data analysis, seven identified affordances used in learning were examined in order to investigate the best use of affordances for learning activities. The main areas of similarities and differences between the stakeholders' perspectives of affordance use are discussed in this chapter. Venable's (2006a) Design Science Research framework demands the development of an artefact. In this instance the artefact is a guide for web interactive multimedia technology affordances use for learning activities in higher education. The Design Science Research framework provides a rigorous tool for exploring issues related to technology implementation. The three domains of the Design Science Research framework used in the research model underpinning the investigation are Solution Technology Invention, Naturalistic Evaluation and Theory Building. Each domain is fundamental to the discussion presented in this chapter.

In order to obtain an in-depth understanding of the findings, this chapter consists of six sections: Section 5.1 Solution Technology Invention – Delivery Strategies and Constraints, Section 5.2 Naturalistic Evaluation – Stakeholders' Evaluation, Section 5.3 Theory Building – Learning Constructive Alignment, Section5.4 Guidelines for Implementing Technology Affordances in Learning Activities, Section 5.5 Lessons Learnt From This Study and Section 5.6 Summary.

5.1 Solution Technology Invention – Delivery Strategies and Constraints

The research has provided valuable insights into how academic developers, lecturers and students use Elluminate to achieve the intended learning outcomes in learning environments. This is more valuable than a study focusing on just the technology affordances, which would describe use without establishing what contextual attributes were appropriate to guide future use. The analysis of all the case studies informs the following summaries of how each affordance was used in the university learning context. This is followed by the evidence from the four cases which demonstrates how each affordance was used in a blended learning environment – learning in both physical and virtual spaces, as students and lecturers were not always in the same room.

All Cases – Screen-board

This research found that although the screen-board provided opportunities for student-lecturer interaction with its tools such as desktop sharing, highlighter, pen, shapes and eraser, the tools were not always used as MS PowerPoint was usually used for lecture presentations. The screen-board on the web provided the ability to write on a blank screen, as well as on a slide and to share other applications, such as EndNote and MS Word. This was a new feature that the lecturers needed to include in their learning activities during web learning sessions. In Case 1, the lecturer appreciated the screen-board's capacity to display MS PowerPoint slides and images; especially medical images. In Case 2, the lecturer appreciated the ability to use the screen-board to provide lectures and for students' assessment where students presented the results of their group discussions.

All Cases – Text

From the lecturers' and academic developers' points of view, it was hard to speak while texting. Receiving public and private messages or responding to private messages while managing the class and speaking to the whole class was difficult to conduct. Texting diminishing the user's focus has been studied in the research on texting while driving (Farris 2011; Hosking, Young & Regan 2006), who found that texting while driving lessened the driver's focus and hence made the driver prone to accidents.

From the students' point of view, text or chat was preferable to audio when audio is working well, and especially when their audio was not working. In a session where a student did not get the opportunity to use the microphone as it was always in use by other participants, the affordance was deemed problematic. The lack of an opportunity to speak could be caused by technical issues, a large number of students or class management issues. If audio was not available, the students could still type the question using the textbox and the lecturer could respond to it. The lecturer in this situation had a choice between answering the questions immediately or at a later time. As the questions were visible to the class, another student could answer rather than the lecturer. Opportunities for interaction were not limited to lecturer-student or student-lecturer but included student-student.

This research found that text was preferred by the students, but the lecturers preferred audio. Text is categorised as a Web 2.0 activity where text exchange involves instant messaging and chat-room (Crook et al. 2008). Schullo (2007) claimed that text (chat) in Elluminate was one of the multiple modalities that were capable of enhancing student-student and lecturer-student interaction. The lecturers preferred the audio affordance which represented less change in

classroom delivery style. The lecturers often responded to students' text-based questions using audio because it was faster and more immediate.

All Cases – Audio

Lecturers preferred to use audio rather than text so that the students in the class could hear a question and listen to the answer, thus receiving immediate feedback. The academic developers highlighted the importance of having a headset and testing the audio before starting the class to prevent technical issues that forced lecturers to revert to text, for activities where it was not their preferred options. Although the lecturers highlighted the importance of having a headset, not all students had access to the tool.

Audio in Elluminate was used for audio conferencing. Smith (2003) and Lazarevic (2010) highlighted the difficulty of integrating audio into language (learning) curriculum and the need for further research on how to integrate Web 2.0 audio tools in subject curriculum effectively and on the most appropriate teaching methods for enhancing learning. However, the paper did not manage to answer the two questions because of the complexities of learning and teaching components, which requires embracing different teaching methods or approaches. Oomen-Early's (2008) research found that the audio affordance in a research project entitled Asynchronous Audio could improve online students' perceptions of lecturer presence, student engagement and the lecturer-student interaction. In this research, audio was found to be useful for the provision of immediate feedback and discussion.

This research found that the audio affordance supports interaction and is an improvement on reading large quantities of data. Earlier Web 1.0 virtual learning environments were mainly text-based. The web pages were static as two-way interactions were not possible. In Web 2.0 environments, real-time collaboration is enabled. When chatting, the lecturer needed to scroll up and down after answering a question, to point to the next question, which was written before the lecturer finished explaining the answer to the first question. With audio, the interaction was more fluent as the lecturer could focus on the audio and encourage the students to ask questions and provide feedback.

All Cases – Emoticons

The emoticons affordance was used by all stakeholders to get students' responses and to attract attention. It was used by the students to get the lecturer's attention when they wanted to access the microphone to ask or answer a question. One emoticon called 'hand-up' was highlighted as being useful by both academic developers and lecturers. The reason the lecturers liked the emoticon affordance was because they could address the students who wanted to interact by looking at the number beside the 'hand-up'. The lecturer's attention, such as looking in a particular direction, could not be perceived by students but the affordance enabled requests for attention with equity and fairness. The applicability of the affordance to a small number of students when interaction is required has a beneficial effect on classroom management.

Emoticons were used by the academics to update the current status of the students during a learning session. As there were no physical cues such as facial appearance or body language, lecturers and students depended on emoticon affordances. Emoticons were used by the

lecturer, for example, to ask the students to raise their hands if they had completed a task (Wang 2008). The value of non-verbal communication was important to any interaction.

This study found that the students could raise their hands at any time in Elluminate without being prompted by the lecturer. The 'hand-up' emoticon used by students to get attention, rather than by the lecturer to manage the class, was not mentioned explicitly in the Web 2.0 literature. Web 2.0 provides opportunities for students to ask questions in a collaborative way (Coutinho 2012). The interaction between lecturer-student, student-student and student-lecturer provides a new rich method for learning on the web (McEachron, Bach & Sualp 2012). A lecturer normally ascertains whether students have understood a concept presented before continuing with a class and can create a learning environment where the students can ask relevant questions. The students who do ask questions during a lecture benefit from using an emoticon to attract the lecturer's attention.

All Cases – Recording

The recording affordance enabled the lecturers or academic developers to record the web session for future use by the student group. A student who missed the web session could watch the recorded session using the normal rewind and forward functions at their convenience. Recorded sessions were also useful for revision prior to exams.

Shoemaker (2010) claimed that recorded video was independent of internet connection and assists in strengthening the subject when used 'in tandem' with real-time interactive video conferencing. Park (2010) stated that increases in infrastructure reliability have enabled a

concurrent increase in the use of video and recording affordances in blended learning environments.

In all cases, recording was used to accommodate students who were absent from class.The recorded session could be used again in the subsequent semester to provide students with a recorded talk given by a guest speaker from industry. This gave students a view of the subject material from an industry specialist. With the recorded session, the lecturer did not have to invite the guest speaker again within a short period of time.

Elluminate affordances were evaluated in terms of constraints because technology in the learning context was the focus in the Solution Technology Invention domain. The constraints highlighted during the stakeholders' analysis were discussed in terms of organisation, infrastructure and people. These three aspects are similar to the technology, organisations and people framework (Checkland 1981; Laudon & Laudon 1998; Richardson et al. 2011). Use of the framework enables the affordances to be viewed in terms of situated technological, organisational or people generated constraints. A further contribution of this study is the mapping of affordances with their constraints. The constraints are discussed on the basis of evidence derived from the stakeholder analysis and the literature review.

5.1.1 Affordance Use and Class Management

Elluminate is a complex web interactive multimedia technology with multiple affordances (Md Ali & Richardson 2011b). There was a need to manage the learning and teaching interaction using the affordances according to the number of students in a web session. The number of students in a cohort is seen to be a constraint to the use of some affordances. This

is emphasized by an academic developer *"You can run a session of five people (in Elluminate). If you run a session of twenty people, I think it would be difficult. If you are running a session of thirty people, that is very difficult. Over forty people, I would say impossible because there are too many people to manage"* (Academic Developer Case 2). To interact with a large number of students using Elluminate the students needed to be divided into smaller sub-groups. With Elluminate, lecturers could organise the students into small groups by using the screen board break-out rooms. *"One possibility is creating groups when you have forty people. You can create ten groups of four students and create break out room where the four people can do discussion and then they can come back and deliver the discussion summary to the other nine groups"* (Academic Developer Case 2).

This view was supported by the lecturers. For example, *"The cameras would show me their pictures (videos) and I allowed maximum simultaneous talkers. I did not turn students off"*. The audio affordance was optimized in this case. *"They were allowed to cut across. It was easy to do because I have a small group of students"* (Lecturer Case 1). In Case 3, Elluminate affordances were used in classes containing small and large groups. The affordances were used for an interactive revision with questions posted by the lecturer and students provided possible answers before the questions were discussed in the small group sessions. In the large group of students, audio and screen-board affordances were used to demonstrate the steps needed to calculate and display results in software such as MS Excel in a physical classroom environment. In Cases 1, 2 and 4, Elluminate affordances were used in small groups of students.

In managing Elluminate affordances, a classroom management solution was imposed by the lecturer by enabling only one speaker at a time. The students could take turns to use the audio

or find another solution to ask question using text."(*When) the student tried to get an opportunity to speak … but failed, she typed in the textbox"* (Student Case 4). The student also stated that in a different session where maximum speakers were enabled, the technology worked well but the organisation of the class felt chaotic. These experiences emphasise the importance of managing the affordances in a web session.

The lecturer needed to choose the appropriate learning approach according to the number of students in a web session class. In the virtual study group paradigm, the number of students on the web ranged from two people, which was like a telephone conversation, to a large number of students, which was like attending a lecture in a lecture hall (Bader-Natal 2009). This study found that Elluminate had been used for small groups as well as for large groups of students. The number of affordances enabled for a limited number of students was greater than in the large group. Virtual classroom management for small groups allowed for more interaction.

In designing and planning, using video conferencing was not recommended to support learning activities by any of the stakeholders in any of the cases investigated for this research. Technical infrastructure provided by the organisation and owned by participating students was cited as the main constraint to the use of this affordance, at the time the study was conducted.

Lectures are usually a didactic presentation or one-way communication. However, using Elluminate students could initiate and create a two-way communication to ask questions. Video conferencing was not used due to technical constraints but recordings of lectures and recorded videos of guest speakers were regarded as useful to support learning.

When using a web interactive multimedia technology such as Elluminate to conduct web learning activities, the time is typically limited and shorter than in a normal class. The scheduled time ensures the availability of all participants who may be located in different geographical time zones and be operating with different daily schedules.

As mentioned by an academic developer, *"Some people do not go more than one hour (in a web session). Even lectures do not go for one hour. They go for fifty minutes. (This is because in a web session) the learning is too intense; you have got to be really concentrating if you are the moderator or a participant. You really have to be concentrating all the time"* (Academic Developer Case 2).

This was supported by the lecturer in Case 1 where the time zone between interstate and overseas students was taken into consideration at the beginning of the semester to set the class time. *"...the daylight saving and different time zone ...(the classes) ended up between 7 and 9 or 8 and 10"* (Lecture Case 2).

The students also highlighted time issues when using Elluminate. The time to handle and manage technical problems such as login problems consumed time, which made some of the students lose 30 minutes of the session time just to log into the web session. This was because in the evening they were already tired and some of them needed to go to work after the session. However *"when it works well, it is fantastic"* (Student Case 4).

Reuben (2008) stated that time is an important requirement when using Web 2.0 applications. In an interactive session, time must be scheduled to reply to questions and give feedback to comments. The Australia Government (Department of Education and Early Childhood

Development Victoria 2010) also indicated time as a challenge for staff creating class schedules when students were located in different time zones and attending a class that used real-time communication. Different download capacity also impacted on the students' participation in learning activities. Download capacity is important to consider when designing web learning environments but it is usually related to the server in use and not to the time of day (Deumert& Spratt 2005).

5.1.2 Affordance Related Communication Constraints

Interaction in web space was different from that experienced by the students in a traditional physical space where the students' facial expressions and non-verbal communication cues were obvious. Affordances such as emoticons were often used to replace non-verbal communication cues. For example, the hand-up emoticon was used by the students to attract the lecturer's attention and polling was used by the lecturer to assess whether students had understood a concept.

Among the highlighted affordances for interaction mentioned were: emoticons, including 'hand-up' and 'smileys'; audio; text; and polling. "*Hand-up is better than the smiley face because it puts a number next to the student's name. So the teacher can let three questions and then take a break and start answering the questions by looking at number 1 (beside the hand-up)"*(Academic Developer Case 1). This shows the emoticons affordance is used during interaction for students to get the lecturer's attention and for the lecturer to organise and manage the students during a web session. The meaning of 'hand-up' was understood by students and lecturers.

Some lecturers preferred the physical class where personality could be used to engage students in an entertaining manner and get the message across. Personality or charisma could be used to command the students' attention. *"When you spend time talking in front of a group, you can use your personality to get things across in a lecture. It is really much harder to do that in a purely online environment"* (Lecturer Case 2).

The students stated that a web session was almost like in a physical class *"almost like being in a classroom"* when it was working properly (Student Case 4). When compared to collaborating using just e-mail, which is text-based with emoticons, Elluminate, provided a space where the students could co-author and collaborate.

In web sessions, non-verbal communication was important for learning but not available in a traditional form. However it was supported by emoticons and video. A shared understanding the use of affordances enabled some non-verbal communication. This finding is similar to that of Rojas, Kirschenmann and Wolpers (2012), where emoticons compensated for a lack of non-verbal communication by enabling the display of emotion. Goodwin et al.'s (2010) study also indicated that real-time collaboration provided the ability for interaction similar to face-to-face engagement, when compared to asynchronous technologies such as e-mail.

The stakeholders in this study acknowledged the ability of Elluminate to enable face-to-face student-lecturer engagement. However they still found face-to-face classes preferable. This may be because lecturers and students rely on understood intuitive behaviour in traditional classrooms.

5.1.3 Technical Infrastructure

Technical infrastructure was mentioned as the main constraint for any use of Elluminate. Technical problems delayed logging in to Elluminate, video download and the use of multiple affordances during web sessions. All stakeholders identified similar constraints but with differing interpretations, that reflected their different position in the university setting. For example, they all agreed that infrastructure was a major technical constraint to Elluminate implementation. As expected, academic developers viewed these issues from a technical stance, whereas the lecturers considered them from a learning and teaching perspective.

Academic developers believed that the infrastructure was dependent on the organisational server operations and not all were working well. However, the lecturers saw infrastructure as the technological ability to support the learning activities and the number of students in a particular web session. This can be seen from a comment one academic developer made that the major constraint to audio and video use was server capability and broadband bandwidth. *"There is one or two of them if you hit one of those servers, it would not work"* (Academic Developer Case 1). Lecturers were focused on learning activity management and saw the major constraint to audio and video use to support interaction during web sessions, as the number of participants. *"We found three (simultaneous speakers) is enough as it is difficult to manage several people talking at the same time"* (Lecturer Case 4).

The students complained about login time delay and the length of time the university took to rectify technical problems. Sometimes they experienced technical problems during the session and this also caused a reduction in scheduled learning time. Students lamented that *"(it takes up) to 20 minutes to sort out technology that takes out from our precious tutorial time"* (Student Case 4).

Oliver's (2001) study indicated that the larger the number of students, the more likely it was for infrastructure problems to occur. In this study the academic developer said group size did not matter. IT infrastructure has improved and technologies, such as, Elluminate are becoming more robust. Lecturers disagreed and stated that the number of students impacted on classroom management and interaction levels.

This research indicated that the university infrastructure plays an important role in contributing to the realism of activities to be conducted in a web interactive multimedia technology environment. The current study shows that there was a delay when using audio to respond to a lecturer's questions and sometimes the message was difficult for the students to understand due to background noise coming through the speakers.

The infrastructure should be able to accommodate the bandwidth and data transfer to enable multiple affordances and multiple stakeholders' participation. In this study, the audio and video were the affordances subject to many complaints from stakeholders. However, according to the academic developer, audio problems were easily mitigated compared to video problems. *"Audio problems are solvable. Video is sort of pushing things a bit"* (Academic Developer Case 1). The lecturer also supported the importance of infrastructure to enable the learning activities conducted in Elluminate. The university needs to prepare, manage and maintain the university infrastructure *"It was technical, the university network just could not handle it, basically"* (Lecturer Case 2).

The students also experienced the ups and downs of using Elluminate. Sometimes the web sessions worked well and sometimes it was a nightmare getting the session operating.

"*Sometimes it is really well. Sometimes it is a nightmare*" (Student Case 4). Although the headset was used, as suggested by the academic developers and lecturers, the students still experienced audio problems such as whooshing sounds or echoes depending on the available hardware devices and web access available to them.

5.1.4 People Initiative

The study showed that training was needed for the lecturers and students to operate Elluminate effectively. Lecturers were supported by the academic developers to plan and practise learning activities to ensure that the best possible learning outcomes would be achieved. The lecturers provided students with a session for them to familiarise themselves with Elluminate before the first actual lesson. The Victorian Government, Department of Education and Early Childhood Development Victoria report (2010) stated that technology places demands on the lecturers' time due to additional requirements during planning and implementation. Lecturers need to spend more time exploring the emerging technology to ensure familiarity to make the use of the affordances in the best possible approach.

Although the system was deemed easy-to-use by all stakeholders, practice sessions were still important to ensure the effectiveness of every web session and to familiarise the students with the learning environment. Although some guidelines were available within the application and the stakeholders were familiar with the functions and even the buttons operating the affordances, they still needed to explore the emerging application and use of affordances. If the application followed a normal standard for web applications, then the stakeholder would just need to put a small amount of time into exploring the affordances available in the applications, prior to use.

The academic developers did not mention the importance of practice sessions for lecturers and students, but training for lecturers was mentioned. *"The training is actually done by information technology services"* (Academic Developer Case 1). This may have been because the direct customers for the academic developers were the lecturers and they wanted to familiarise the lecturers with the technology and contextual use of the affordances.

The lecturers regarded the provision of a practice session or short training workshop as critical prior to conducting the first class. In a subject where students had no experience with Elluminate, the session was especially important to facilitate an interactive web session *"Important to get used to the technology before they actually using it"* (Lecturer Case 2).

A lack of training was mentioned as one of the common people constraints to adoption. Symptoms of adoption failure, such as, mistakes and time wastage were often blamed on the new technologies. Training was important but it did not suit all lecturers. In this study, two types of training were described: the first was technical training on the functions available in the system and the second was support for changing pedagogy and learning activities to be used with students. This study found that it was also important to train students before running a web session.

Timely rescue from technical problems impacted on adoption in a positive way. Technical support including optional classes and online resources prevent lecturers needing help during classes. The learning and teaching support typically comprises contacts that assist lecturers to explore new learning activities designed to achieve the desired learning outcomes.

The role of the academic developers was mentioned by an academic developer *"I support them in teaching" (Academic Developer Case 2).* The support provided by the academic developer in this instance was *ad-hoc*. The individual base support for lecturer was a hot line to ask the academic developer questions. For group-based support, there were several sessions where a group of people got together to discuss the use of Elluminate in blended learning environments. Through the group based support, a community of practice was created. The lecturer also mentioned the importance of having a support team when facing technical as well as learning challenges. *"There have been challenges but people (the supporting team) have been very supportive in workaround"* (Lecturer Case 1).

In the literature, technical support and training is the common people constraint as mentioned in the technology, organisation and people framework (Laudon & Laudon 1998; Richardson et al. 2011). This study found that support teams were important to assist people and further enhance the adoption potential of the new learning system.

5.2 Naturalistic Evaluation – Stakeholders' Evaluation

The stakeholders' opinions were evaluated in terms of the usefulness and ease of use of Elluminate's affordances (Davis 1989; Venkatesh, Davis & Morris 2007). Information gathered included whether or not the stakeholder would continue to use the application in the future. Although Elluminate affordances were found easy-to-use, the lecturers would appreciate further assistance in designing subject delivery. Guidelines describing how and when to use the affordances to achieve the intended learning objectives rather than just technical instructions were deemed important.

5.2.1 Useful for Learning

Web interactive multimedia technology affordances were found to be useful for collaboration and interactivity between lecturers and students in a virtual web space. The affordances were especially useful for short, focused, collaborative activities. A brief face-to-face interaction before the virtual conversation class was useful to facilitate relationship building. The physical gathering was valuable in forming the lecturer-student and student-student relationships. Pre-class conversations ensured that people felt more connected. The lecturer could then provide a topic overview in the web session and then use the technology affordances to drive discussion or to check students' understanding using polling (Noel 2010).

The 'usefulness' of Elluminate was not evaluated in terms of the students' achievements, but according to what the stakeholders (academic developers, lecturers and students) perceived as useful for the delivery of learning activities. Students participated in activities that assisted them to construct their own learning (Biggs 1996, 2002; Biggs & Tang 2007). The academic developers, lecturers and students all agreed that Elluminate affordances were useful.

Elluminate was useful for lecturers to get access to students outside traditional physical classrooms boundaries. The uses of Elluminate were directed towards teaching physically and geographically distant groups of students in a collaborative and interactive environment. This was evident when travel was banned and the lecturer or students could not travel to campus. *"It shows its use because it is use at the time when you needed it for example when you have a disease and you could not travel. (That is) excellent" (Academic Developer Case 1).*

Web interactive multimedia technology such as Elluminate is useful as lecturers and students could communicate virtually in a classroom-like environment. However, the different time

zones needed to be considered to schedule appropriate sessions so that most of the students could attend simultaneously. Overseas students were able to get appropriate lecture session although travel was banned by the university for face-to-face teaching due to the outbreak of an exotic disease. The lecturer needed to use Elluminate to conduct classes with students located remotely. *"There are a number of students who are supposed to graduate and wanted to graduate within a couple of weeks"* (Lecturer Case 2). The lecturer used Elluminate to provide traditional lectures and follow-up discussions within the scheduled semester.

Students could also collaborate with their peers to increase their learning and construct their understanding of specified learning objectives. Students engaged in peer study or project groups to discuss assessments of specified topics. The students also found Elluminate affordances useful in terms of getting in touch with the lecturer. "*Never met or seen face-to-face but being able to talk to everyone important to collegial and communicate to each other"* (Student Case 4). Web interactive multimedia technology affordances enabled students to get together without physically travelling to a particular location. Students and staff attended virtual classes. "*With distance students, though, Elluminate is quite useful and gives us a direct opportunity we can get (without travelling) to be "with" the tutor and other students"* (Student Case 4).

'Useful' was one of the predictors used in the technology acceptance model (Davis 1989). Elluminate was found useful by the stakeholders in this research despite the challenges they faced as early adopters (Rogers 2003). From a learning perspective, academic developers, lecturers and students all stated that Elluminate was useful for remote communication and collaboration. Academic developers and lecturers recognised the ability for web interactive multimedia technology affordances to enhance blended learning environments.

An academic developer commented upon the screen-board's ability to complete a specific action such as jump to a specific slide without scrolling up or down the slides. *"This is handy. You can use the controls to control the slides…it is a drop down underneath that…jumps to say slide number twelve. You can jump down it automatically picks the name of the slides. So if anyone asks you questions and you…jump straight into that"* (Academic Developer Case 1). Most web technology users prefer to look at the first screen without scrolling (Delialioglu & Yildirim 2007). Having the ability to jump to a specific location without scrolling is a useful advantage.

A lecturer compared Elluminate with a previous virtual learning system that was just text-based. *"It was really a bit of a challenge because you would be about two steps ahead of the students. So responding here but you have to go back two steps because there would be texting input"* (Lecturer Case 1). Elluminate has many affordances. The use of images on the screen-board was found particularly useful *"like light-years ahead. I think it is a fabulous technology"* (Lecturer Case 1).

One of the students compared Elluminate with talking on a traditional telephone and corresponding using e-mail. The one application provided the affordances of two earlier technologies used to communicate separately. The student found that Elluminate "*allowed the group to get together"* (Student Case 4). *"Elluminate is better than e-mail as it is in "real time" and we get more immediate feedback"* (Student Case 4).

The affordances used in learning activities were directed towards achieving the intended learning objectives as the subjects were designed according to the principles of constructional

alignment (Biggs 1996, 2002; Biggs & Tang 2007). Another use of the affordances was the opportunity and possibility of meeting, listening and responding to enquiries that arose during the learning process. Use of affordances such as the 'hands-up' with numbers emoticon and polling made it easy to ask questions as well as to respond to enquiries during a class (Stowell & Nelson 2007). If student asked a question or did not understand a concept, further explanation could be provided immediately.

5.2.2 Easy-to-use

This research found that Elluminate affordances were easy-to-use. Minimal training was provided to lecturers and students. This was because Elluminate technology affordances followed the conventions of other web applications that were familiar to end users. Elluminate was, easy-to-use, easy-to-remember and easy-to-learn. The application was built on an understanding that end users efficiently use e-mail, chat or instant messenger (Conte, Massollar, Mendes & Travassos 2007).

The current research revealed that academic developers regarded training as an important element in the adoption of Elluminate. However, some of the lecturers who used Elluminate did not want formal technical training. Stakeholder groups presented different perspectives of what training could provide. The lecturers were more concerned about how to use affordances to achieve the desired learning outcomes rather than how to click a button to speak to the students. *"I think I largely taught myself really*" (Lecturer Case 4). The lecturers could just jump into the system and straight away play around with it to see the potential and make use of the opportunities and resources available, as the lecturers' in this research were early adopters, as described by Rogers (2003) Diffusion Of Innovation Theory. Early adopters were

one of the five categories of adopters located on a sliding scale between innovators and late adopters (Rogers 2003). The lecturers were not responsible for the development of Elluminate but were competent to train themselves, with support from the support team in the learning unit and the academic developers.

All lecturers provided time and space for the students to play and experiment with Elluminate, before starting the first actual lesson at the start of the semester. With a lot of affordances to use and explore, this was intended to help the students prepare for class interaction and try to solve any access-related technical issues. Once students logged on to the system, they were expected to participate in the web session discussion and interactive activities. However, the students did not regard training or practice as important because it was not mentioned during their interviews. This demonstrated that they could easily navigate through the system. Perhaps the students were already familiar with the affordances that were similar to common web applications.

Interactive and collaborative learning activities, using Elluminate affordances were easy-to-use, when the class size was small. Having a small number of students, the technical problems were mitigated and the interaction between the lecturer and students was problem free. In that research, there was only one case with a large number of students in the cohort. In this case, the main affordance used was the screen-board, as the students were physically in the same room as the lecturer. A number of the affordances were not necessary for delivery in this instance as they were more appropriate for communication where the students were separated by physical geographical distance. The academic developer suggested several ways to manage a large number of students on the web, as Elluminate has tools designed to accommodate the situation. The suggestions included dividing the students into several smaller groups, so that

the lecturer could use the breakout-room for discussion. Representatives from each group could then present to the whole class.

From an academic developer's perspective, it was easier to manage small groups than large groups, in a web session. When Elluminate is used to support collaboration and interactivity *"over 40 students, I would say, is impossible … too many people to manage"* (Academic Developer Case 2). However, the number of students did not affect the technical problems experienced. *"If it is not working well with five people it will not be going to work well for ten"* (Academic Developer Case 2).

From the lecturers' perspective, classroom management was an issue as the student group became larger. Lecturers needed to manage interaction and collaboration using the affordances available during the web session. Some lecturers limited the interactivity by limiting the numbers of microphones enabled at any time. Some lecturers received feedback from students using audio or text but only responded using audio. Lecturers' found concentrating on speaking and texting to the whole class difficult. In one case, the lecturer did not have any classroom management issues as the number of students in the session was smaller than the number of simultaneous speakers allowed by Elluminate. *"I have a small group. It was easy to do."* (Lecture Case 1). In Elluminate, audio and chat were easy-to-use with a small number of students.

5.2.3 Technology Affordances Improvement: Easy-to-use and Useful

The following affordances were commonly used to facilitate learning activities:

- The screen-board was used because it was easy to display MS PowerPoint slides and images, write on the screen, point, illustrate and jump to a specific slide without having to scroll
- Audio was used mainly by lecturers in order to conduct traditional lectures and to answer questions
- Text was used mainly by students to ask questions and give feedback and comments

Affordances were used to enable interaction and collaboration that facilitated the learning process and consequently the delivery of learning objectives.

The interaction provided by affordances such as audio, emoticons, text and screen-board enabled the students to ask questions and receive responses, in real time during the session. This enhanced the students learning as the students could obtain immediate responses. The affordances available in Elluminate mimic face-to-face classroom interaction. The emoticons enable lecturers to receive cues or prompting from the students where physical facial cues are unavailable. In face-to-face sessions, abstract communication cues such as facial expression and body language can be seen by the lecturer. Lecturers interpret students' non-verbal expressions and can take steps to re-engage students if they appear to lose their focus. An academic developer stated that the video affordance was essential for understanding classroom non-verbal communication. It was possible to conduct classes with just audio to interact with students but classroom management of a large group was adversely affected when high levels of interaction were necessary. A small class size was necessary to retain high interaction levels between the lecturer and students when only the audio affordance was

used. Visual cues provided by video could also substitute for some screen-board features and the use of emoticons such as ‘hand-up’.

5.2.4 Technology Experience Improvement

Lecturers compared the use of Elluminate to previous experiences with Web 1.0 virtual learning environment software applications that were typically text-based. Although video conferencing required a special room and technical infrastructure for the equipment to operate the visual cues were excellent for mimicking face-to-face classroom interaction and collaboration. Audio conferencing was compared to using the telephone. Many people were included, but without visual aids relationship building and information visualisation were found to be difficult. In the case studies conducted video was considered unimportant and not a necessity for lecture delivery. Technical problems often reduced the limited time available during web sessions. As the text, screen-board, pointers and break-out room affordances could be used for private messages and discussion, video conferencing was not necessary.

With web interactive multimedia technology, time and energy are the main investments by stakeholders when they adopt it for the first time. However, Elluminate affordances are similar to classroom techniques, such as, chalk and blackboard or marker and whiteboard. Teaching using a technological system such as web interactive multimedia technology may seem to some people to be complex and a waste of time. Technological system upgrades also influence adoption by means of improved ease-of-use and usefulness (Davis 1989). The potential negative impacts of Web 2.0 affordance adoption and the creation of virtual learning environments is the loss of physical contact and an increase in student preparation and independent study time.

Web interactive multimedia affordances enable lecturers' to respond to students faster than technologies such as e-mail. Additional functionalities such as recording are also available. Web 1.0 virtual classroom platforms implemented by the university were often just text based (e.g., chat room). Elluminate affordances provided an improvement. The students could be given feedback in real-time during a lecture. Much more could be achieved when using a variety of available affordances (e.g., audio, screen-board, chat) rather than just text-based communication. Using just text-based applications, the lecturer needed to scroll up and down within the textbox to answer questions. With Elluminate, the lecturer could use audio to answer in real-time. This was faster than typing the answer.

The stakeholders' analysis of Elluminate multimedia affordances found the learning and teaching environment to be an improvement on virtual classrooms that only had access to textor audio or video technologies. Academic developers and lecturers found Elluminate to be useful for conversations between more than two people.

5.2.5 Attitude When Facing Problems

Although Elluminate affordances were useful and easy-to-use, there were some problems experienced, as the technology was new. Some stakeholders remained positive despite minor technical issues that impacted on their ability to conduct learning and teaching activities when problems were not resolved in a timely fashion. Other stakeholders reported that the technical problems experienced meant that they would not attempt to use the technology in future classes. Lecturers and students needed to understand that they were using an emerging technology. It was important that lecturers did not panic or become overwhelmed when faced with technical problems. Students often experienced login problems that lecturers managed

through checking processes before the classes commenced. These problems were expected and not considered a significant issue. *"There have been challenges but people have been very supportive in workaround"* (Lecturer Case 1). In this case, the lecturer had a positive experience with Elluminate and would recommend the system to be used by others. Some lecturers in this study described negative experiences which related to the technical problems faced and support received.

In addition to the technical constraints to Elluminate adoption in the classroom; there were learning and teaching pedagogical issues. The use of an emerging technology requires planning and changes to teaching resources. The same class planned for a traditional chalk and talk or didactic approach may not work effectively in an Elluminate classroom. It is important to ensure that lecturers have the appropriate expectations with respect to changing pedagogy and curriculum resources when using emerging technology.

The students also encountered technical problems during web sessions and they found the experience frustrating and time consuming. Students described login problemsand, interestingly, varied sources of support to resolve issues. Peers and lecturers were approached prior to formal requests to technology support teams. Technical issues were a major consideration in stakeholders' adoption decisions. A positive attitude towards web interactive multimedia technology was not in itself sufficient to influence the adoption of emerging technology in learning practice. There were a number of other elements involved, such as organisational management decisions and support.

As yet there exists little research evidencing the best practice uses of Web 2.0 affordances in higher education. In order for emerging technology to be adopted and implemented, it is

essential to understand the nature of the learning activities and appropriate technology supports. The reasons for the adoption and implementation of a particular emerging technology, as well as, the attitude when facing problems whether to go on or just quit may be influenced by stakeholders' belief in the usefulness of the technology (Postman 2004). If a stakeholder believes the technology affordance is good they will feel positively towards the risk of choosing the emerging technology.

The academic developers seemed to believe that the technology should be used only if necessary, in a blended learning environment and when the affordances assisted the delivery of the intended learning outcomes. If using the technology during an activity enabled students to complete the intended learning activities or assessments, it was deemed useful. It is important to evaluate the use of the technology affordances to achieve the intended learning objectives. The academic developers assisted the lecturers in terms of using appropriate affordances in a web learning sessions to achieve the intended learning objectives. "*How to use this to achieve the intended outcome with my students? Then this is where I help. I would say "What about we try if this fits you? Would that affordance suit you better?"* (Academic Developer Case 1).

Elluminate was referred to as *"fabulous"* because it was more than just text-based and provided a multitude of interaction opportunities (Lecturer Case 1). The ability for the lecturer to use images was important to learning as it augmented the construction of students' understanding and eased the transfer of their knowledge to clinical practice. The importance of implementing the appropriate affordances in learning activities was described by a lecturer who used a hammer as a metaphor. "*They are great if they are used properly. It is like having*

a hammer and a nail. Somebody who knows how to use a hammer, then hammer is great. Somebody who does not know how to use a hammer, it is dangerous" (Lecturer Case 2).

The students described their experience using Elluminate as "*fantastic*" (Student Case 4) when the web session was working smoothly and well. *"I really enjoyed the Elluminate session. Technology problems side of things is minor compare to what I get from Elluminate session"* (Student Case 4). Technical problems were the major constraints. The students also appreciated opportunities for student-to-student interaction.

Students in this research largely fell into the group that believed technology was a tool to solve problems and assist in their learning Postman (1992, 1994). The lecturer who referred to Elluminate affordances as a hammer belonged to Postman's (1992) group that believed technology was a tool to solve problems and assist at work. The lecturers and academic developers used the emerging technology to teach and participate in online classes. When facing technical problems, a person could adopt a positive approach and investigate alternative options or could negatively refuse to continue with the technology adoption strategy. People often change their personal opinions based on good experiences, which is important for organisations to consider when planning an emerging technology adoption.

All the participants in this research viewed Elluminate as a tool. It was recognised that there were other software, technology or platforms that could be used to achieve the same goal. Only a few lecturers had previously utilised web interactive multimedia technology in their learning activities, at the time of the research. This result suggests that Elluminate was not the technology regarded as the first medium of choice.

5.3 Theory Building – Learning Constructive Alignment

Analysis of the implementation of constructional alignment was assessed from the subject guide information and stakeholder interviews. Subject guides were used as the primary evidence that learning activities and assessments in all of the case studies were designed using constructional alignment to underpin pedagogy and curriculum resources (Biggs 1996, 2002; Biggs & Tang 2007). The subject guides included descriptions of learning objectives, learning activities and assessment. Some lecturers planned the use of web interactive multimedia technology affordances ahead of time and others made decisions during a particular web session.

5.3.1 Design and Planning to Meet Intended Learning Objectives

All stakeholders identified the need to plan learning and teaching activities to achieve intended outcomes including a plan for the use of an emerging technology. Academic developers and lecturers agreed that the use of technology should fit the learning purpose and it was not useful if this process of constructional alignment followed by curriculum resource and affordance alignment was not followed (Biggs 1996; Biggs & Tang 2007).

The first planning step for a lecturer is the development of learning objectives. This task is completed before delivery decisions that involve technology choices and implementation. Technology choices must suit the situation. Academic developers and lecturers shared similar opinions on the need to use a technology purposefully, which indicates that they belonged to Postman's (1992, 2004) second group.

Planning delivery was needed to increase the chance of having a highly successful web session. Prepared material was useful for the lecturer and ultimately saved time preparing for future sessions. For example, having MS PowerPoint slides is considered standard teaching preparation and would be completed prior to a traditional class or a web session.

When using web interactive multimedia technology, students are expected to complete some self-directed learning as the contact time in web sessions is limited. This research highlights the importance of decisions about affordance use being made at the subject design stage. The preparation before the semester begins is important in order to provide the best opportunities for all students to achieve the desired learning objectives. The aim is to provide the best learning environment possible given the resources and infrastructure provided by the university. By having a clear subject guide, the students are better able to manage their learning and have clear expectations of the subject learning outcomes.

Preparation is important to support learning (Armstrong 2008). Planning provides a roadmap for both lecturers and students. All intended learning objectives, weekly teaching activities and assessments are included in a guide to subject delivery given to the students prior to commencing the subject. The materials should be prepared in advance, put online and made available for students to download. Students should be required to build their skills and understanding prior to attending class. The lecturers are expected to encourage the students and provide opportunities for students to ask questions and provide feedback. This is in line with the constructive alignment concept in learning that promotes the need to align the learning activities to achieve the desired learning objectives (Biggs 1996, 2002). Web interactive multimedia technology affordances could also be used in a flipped classroom, where a video of a recorded lecture is given to students before a web session class and the

students then focus on discussion in the web session. This study did not cover the flipped classroom case because no participant used a recorded lecture followed by discussion in Elluminate. A lecturer stated that what was conducted in a physical classroom could be conducted in a similar fashion in a virtual classroom, in this case using Elluminate.

This lecturer also highlighted that the learning objectives were *"to guide the students* and *give them some information to guide their learning"* (Lecturer Case 1). The subject guide that contains the learning objectives setup the students' expectations. With the given objectives, the students are expected to do more *"self-directed learning"* and as the lecturer informed *"I never pretend that I am going to cover everything in the class and they never have to look at a book or anything else"* (Lecturer Case 1). Class time is limited so an approach is always needed. *"Usually we overview the lecture coverage (during the web session). It is impossible to give a three hour lecture in a short period of time"* (Lecturer Case 1).

The students described the approach they experienced in a web session using Elluminate for an immediate real-time discussion. The students were already working and they managed to share their work experiences during the discussion within the limited scheduled time from they own their own separated physical locations. A student said that in the web session they *"get professional kinds of opinions"* (Student Case 4) from the lecturer as well as from other working students as they encountered issues in the assignments or related to the subject. In order to meet the intended learning objectives, the teaching and learning activities and the assessment must be solely directed towards achieving the learning objectives (Biggs 1996, 2002; Biggs & Tang 2007).

Some lecturers just used Elluminate to replicate traditional teaching delivery that would occur in a normal physical classroom. Lecturers sometimes explained a concept in a didactic fashion perhaps facing the wall and without even looking at the students directly. This style of lecturing would not be conducive to learning.

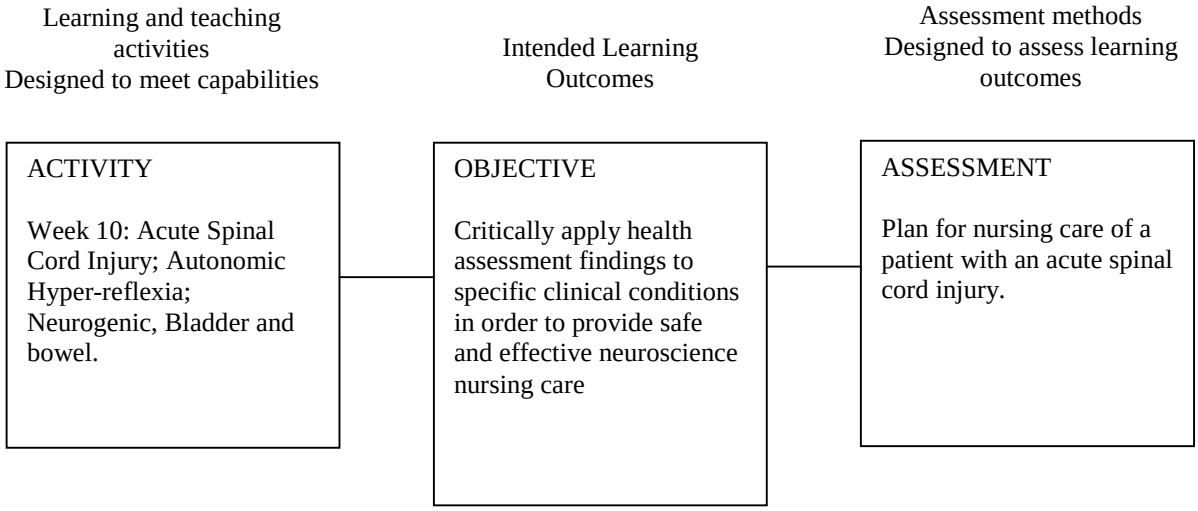

Figure 5.1: Subject design alignment

The way a lecture was usually conducted in the traditional classroom environment was changed to suit the constraints imposed by Elluminate. Since the time available was quite short, the web session was compressed and required students to be guided to start learning prior to class. The lecturer had to make effective use of the time available to reap the full potential.

Updating a subject that is well designed and planned takes less time than developing a new subject. Conversely, time spent on the first delivery of a subject using a new technology for delivery provides an excellent basis for further iterations of teaching and amendments. With the excellent detailed planning of activities and assessments to deliver learning outcomes in

the subject guide, the preparation of a second delivery is not difficult. A lecturer stated that in setting the framework for a subject, it takes longer to prepare the first delivery using an emerging technology but as time goes by, the content and information will be updated as there is no point in teaching something out-dated.

It was important to have an intended learning outcome planned at the design stage as this could help lecturer and students understand the requisite order of learning activities designed to maximise learning. The affordance choices for each learning activity enable the interactions that building learning. *"Thinking of the teachers first before the technology where the focus is on how to use this (affordances) to achieve this outcome with the students"* (Academic Developer Case 1).

5.3.2 Affordance Use Summary

The web interactive multimedia technology affordances were suitable to be implemented for lecture style delivery as well as discussion activities. *"You can create ten groups of four if you like and you create break-out room where the four people can do discussion and then they can come back and do summary of their discussion and one person can deliver to the other nine groups their summary"* (Academic Developer Case 2).

Images were used to highlight significant points and to underpin questions used to probe the students. Students could then seek clarification of the information, issues or topic. The web interactive multimedia technology affordances were important in lecture activities. *"I do use a lot of graphics. So, we go through x-rays, CT scan, MRI and different sorts of things in Elluminate"* (Lecturer Case 1). The web interactive multimedia technology affordances were

also important for discussion and collaboration activities (Gray et al. 2011). The students indicated that the ability to meet virtually was important. *"Never meet or seen face-to-face but being able to talk to everyone important to collegial and communicate to each other"* (Student Case 4).

In each case study MS PowerPoint slides were displayed using the screen-board. The affordances enabled the lecturer to choose whether to provide a lecture in a didactic manner or interactive way. In a web session it is difficult for the lecturer to use their personality to interact with the students and to receive non-verbal communication such as body language from the students. The affordances enabled the lecturer to prompt the students for their current situation. Implementation of several breaks during long session was good for both the lecturer and the students to get refreshed and focus again at the computer monitor.

Students also used the screen-board to provide solutions to problems. Across the case studies the screen-board was the preferred affordance for interactive lecture presentations, lecturer-student discussions and question and answer revision sessions. Students also conducted group presentations in Elluminate.

For interactive lectures conducted within a limited time slot, audio was the main mode of delivery. Lecturers typically used the same MS PowerPoint slides prepared for a normal physical class. Lecturers could use audio to prompt the students to ask and answer questions aimed at clarifying their understanding. Audio was also used in the lecture to explain to the students and further responses to students' questions.

There were several affordances of Elluminate that were used for assessment in the subjects. Academic developers and lecturers designing and delivering subjects often used the polling affordance to assess students. The polling affordance was often used to assess students' current understanding of the subject (Rubio, Bassignani, White & Brant 2007). Polling also marked the end of an activity, to check if the students had understood the topic presented. The result of the polling could be further discussed with the students. Completing polling activities enabled students formative assessment and feedback, that tested the level of student understanding.

The web interactive multimedia technology affordances were used for formative assessment of students understanding. Polling was an effective formative assessment tool *"where you can create an activity where you ask students using multiple choice questions such as A...B...C....D... Students click on their response and* the lecturer *can immediately publish the poll"* (Academic Developer Case 2). Polling and audio affordances were used by the lecturers to get the students attention and to ascertain the level of subject matter understanding where the polling affordance was sometimes used to check students' understanding of concepts presented before moving on to a new topic or concept.

Web interactive multimedia technology affordances, such as, polling and chat enable immediate feedback during a web session. For example, audio feedback can be used to check students' current understanding of a topic. Once the lecturer has ascertained that the students have not acquired sufficient understanding they can address the issue by providing further instruction. If students have acquired the requisites knowledge and skills the lecturer can move on to the next topic.

Web interactive multimedia technology affordances were important to assess the students' understanding of the subject concepts taught before moving on to the next concepts. A lecturer would give an example of the way the emoticons were used for assessment. She would say "*Do you get this because this is really important. If you do not have this concept you are not going to understand the next bit that we will talk about. (If the student indicate that he/she did not understand yet), OK so let's go back"* (Lecturer Case 1). Students would use the specified emoticons to signal to the lecturer that they understood the material presented.

The web interactive multimedia technology affordances were used for informal assessment, as well as, preparation for formal assessment. These practices were important to help students prepare for formal assessment. "*We also do exam practice with her writing questions on the whiteboard and we enter our responses as A, B, C or D"* (Student Case 4).

Biggs and Tang (2007) discussed the importance of aligning assessment tasks, learning activities and learning objectives in order to assure students achieved requisite learning outcomes. Two types of assessments were conducted during the web sessions. The first type was where the polling affordance was used to ask questions. The second type was where other affordances such as emoticons were used to see whether the students were still engaged, to invite students to ask questions and to signal the order of the lecturer's responses.

5.4 Guidelines for Implementing Technology Affordances in Learning Activities

Web interactive multimedia technology affordances are the technology features used by the stakeholders to support learning activities and assessment tasks. Affordances used during web

sessions were categorised into screen-board, text, audio, emoticons, video, polling and recording. The learning activities were broadly categorised into lecture and discussion where lectures involved low interaction and discussions involved high interaction between lecturers and students.

Lecture Session (Low Interaction)

In a low interaction class where a lecture was conducted, the affordances typically used were screen-board, text, audio and emoticons. Video was not recommended by all stakeholders as usage often involved technical problems. Polling was often used to obtain current feedback from the students and to gauge whether they understood what had been delivered. Emoticons affordances were also used to prompt the students. The justification for this choice was the lack of physical face-to-face or non-verbal cues that the lecturer could pick up during the web session. The recording affordance was used when the lecturer wanted to share a lecture with students who were absent during the actual class and for students to be able to revise material prior to formal assessment tasks.

Discussion Session (High Interaction)

In a high interaction class where discussion was conducted, lecturers needed to play the facilitator role. This was crucial in the web or virtual space as visual cues received were from emoticons. Audio was an important affordance during discussions. Lecturers could encourage students to speak by calling the names of students, paraphrasing questions and providing examples. Elluminate can be an interactive discussion platform for the lecturer and students.

Difference in the affordances used in the two delivery modes, were discovered. In lecture classes, students were prompted to respond using emoticons or polling. Low interaction was required as information generally flowed from the lecturer to students. In discussions, lecturers preferred students to respond in audio.

The screen-board was mainly used in lectures rather than in discussions, as it allowed the use of slides throughout the lecture. Discussion-focused activities mainly required the use of the audio affordance Audio was used mainly by lecturers rather than students, who mainly used text or messaging. The guidelines outlined in Table 5.1 provide a conceptual tool to be used by lecturers during curriculum or subject design, in order to obtain the best web interactive multimedia technology affordance for any learning activity. The guidelines are similar to a recipe where the lecturers have the ability to improvise on the guide to suit the subject's needs. The guidelines provide a starting reference point for a lecturer who intends to use an emerging technology affordance to deliver a subject and facilitate students' learning.

Table 5.1: Web interactive multimedia technology affordances guidelines

Affordances	Large group	Small group	Lecturing (Low interaction)	Discussion (High interaction)
Screen-board: MS PowerPoint slides, desktop sharing	☒	☒	☒	☒
Text	-	☒	-	☒
Emoticons	☒	☒	☒	☒
Audio	☒	☒	☒	☒
Video	-	☒	☒	-
Polling	☒	☒	☒	☒
Recording	-	☒	☒	☒

Table 5.1 provide a conceptual tool to be used by lecturers during curriculum or subject design. For lecturing (low level of interaction) with a small group of students, the affordances recommended to be used in the web session are screen-board, emoticons, audio, video, polling and recording. For discussion (high level of interaction), with a small group of students, the

affordances recommended to be used in the web session are screen-board, text, emoticons, audio, polling and recording.

An example of the guidelines illustrated in Table 5.1 being implemented for a subject during the design stage is the three learning activities planned for Week 1 of Business Communication. The planned learning activities were lecture, demonstration and workshop. The lecture and demonstration were planned to be conducted with a large number of students at a low interaction level. The affordances suggested in the guidelines as suitable for the sessions were screen-board, emoticons, audio, polling and recording. Another example is a workshop planned to be conducted with a small number of students and a high interaction level. The affordances suggested in the guidelines and suitable for the session were screen-board, emoticons, audio, text, polling and recording.

Table 5.2 illustrates that this research has provided a planning tool for use at the subject design stage, as the outcome of this research.

Table 5.2: A sample of the guidelines implementation in a subject

Week	Lecture	Demonstration	Workshop
1	Subject overview	Business Communication	Basic Business Communication Tools Activity 1, Activity 3
Criteria	Large group, low interaction	Large group, low interaction	Small group, high interaction
Affordances	Screen-board, emoticons, audio, polling and recording	Screen-board, emoticons, audio, polling and record	Screen-board, emoticons, audio, text, polling and recording

In the light of the practice session based on the case studies, it was evident that there was a need for a change in delivery style. With many affordances, more learning activities could be conducted to improve learning and teaching. If the presentation was just text-based, the interaction on the web required the lecturer to scroll up and down and up again to respond to a

question from a student. With audio, the lecturer could immediately answer a student's question whilst others listened and waited for their turn to ask questions.

5.5 Lessons Learnt From This Study

The implementation of web interactive multimedia technology affordances in university learning environments is complex. Elluminate is a web interactive multimedia technology that is a part of Web 2.0 technology. It can be used for social networking and as a platform to generate content in collaborative environments. Elluminate is not similar to Facebook or blogs where a lot of text is accumulated over a long period. It provides open access, collaboration and web conferencing where people can get together and do more than just talk or watch videos.

The research suggested that time is the crucial element in conducting a successful web session. This research looked at the implementation of Elluminate in higher education, focusing on the use of affordances implemented to support learning activities. The unit of analysis in this research was individual subjects who used Elluminate for learning activities. The infrastructure, organisation and people play important roles in order to minimise adoption constraints.

5.5.1 Design Science Research Reflection

This study used a Design Science Research approach involving technology, people and learning subjects. The Design Science Research approach provided the main framework for this research. It consists of Solution Technology Invention, Naturalistic Evaluation and Theory Building. The data obtained were examined using a qualitative approach. The use of

thematic coding in this study served as an excellent tool for analysing raw data into meaningful themes which provided rich and detailed data for the study. In understanding the approach of conducting analysis, categorisation and themes identification began as early as during data collection. Listening to the stakeholders' responses to interview questions triggered categorisation ideas and initiated the identification of themes. Familiarisation with data was crucial to ensuring that the depth and breadth of data were captured.

The research on web technology for learning adoption by universities is traditionally represented by cases that have used TAM to predict adoption behaviour. Despite its great value to researchers, TAM is a general theory and addressed the prediction to adopt new technology. The shift forward in available web technology affordances in a vast array of applications has demanded a study focused on specific affordances for particular learning activities. Design science research addressed the study after technology implementation and pushed this research to produce an artefact.

Findings from the analysis of each domain of the research's conceptual model identified themes that could facilitate the use of the affordances of a web interactive multimedia technology in university learning environments. This research studied several subjects where Elluminate was used and examined the opinions and experiences of the stakeholders, which led to an in-depth understanding of specific cases. The data have provided rich information and insights pertaining to the case studies, although this research method does not use statistical generalisability (Yin 2009). Therefore, it must be clearly understood that the findings of this research can be used, at best, as a guide to compare or make judgements about the implementation of Elluminate affordances for university learning subjects.

5.6 Summary

The stakeholders' perspectives were used to provide guidelines that have the potential to fast track the adoption of web interactive multimedia technology affordances in higher education. For example, a lecturer who is also a researcher, uses Elluminate in a research project but only for talking and listening to the other researchers. Seven affordances were identified in the stakeholder data analysis in this study. They were screen-board for lectures, discussions and exercises during the web sessions, text in the lectures and discussions, emoticons in lectures, discussions and exercises in the web sessions activities, audio in lectures and discussions activities, video in lectures and discussions activities, polling in exercises during the web sessions to get feedback from the students or to test their understanding and to gain their attention and recording for future use by the students or the lecturer. The important findings of this research are drawn from the rigorous evaluation following the research conceptual model underpinned by a Design Science Research framework that guided data collection (Venable 2006a).

This chapter has discussed the artefact – the guidelines for using web interactive multimedia technology affordances in a subject according to the student group size and the interaction level – as an outcome of the research. The artefact is a guide to curriculum or subject design and a guide to implement web interactive multimedia technology affordances in learning activities. It was noted that the guidelines are like a recipe that the lecture can improvise on to suit the subject. It is important for a lecturer to use the affordances available in an emerging technology in order to achieve intended learning objectives. The next chapter is the conclusion that summarises the thesis and provides suggestions for future research.

6 Conclusion

This study explored the use of the affordances of Elluminate (an exemplar of a web interactive multimedia technology), which were used in four case studies in higher education; from the perspectives of academic developers, lecturers and students. Chapter 5 discussed the research findings that led to the development of an artefact in the form of guidelines to assist academic developers and lecturers designing subject delivery using Elluminate or other technology with similar affordances.

This chapter concludes this study by summarising the research underpinned by a Design Science Framework that enabled this research to produce guidelines for using web interactive multimedia technology affordances rather than just to study the uses of technology in university subjects. The research used a Design Science approach to underpin the methodology which is effective in the development of an artefact as an outcome. This chapter summarises the use of web interactive multimedia technology in university learning environments, presents the contributions of this research to theory and practice, including the development of guidelines, and provides suggestions for future study.

6.1 Web Interactive Multimedia Technology in University Learning Environments

Adoption of Information System Study using Design Science Research

This research investigated the adoption of Elluminate in a university learning environment. There are two prominent theories in the study of technology adoption: the Technology Adoption Model and the Diffusion of Innovation Model. This research looked at the

implementation of Elluminate by lecturers for learning activities with their students in the university learning environment. The three stakeholders' perspectives were lecturers, academic developers and students. The use of the affordances was evaluated through the lens of learning and technology theories.

The potential of a Design Science Research in Information Systems approach to yield an enriched understanding of the implementation of an emerging technology for learning in higher education was demonstrated in this research. The Design Science Research framework was a successful framework for the evaluation of Elluminate implementation (Venable 2006a). It provided evidence for the development of guidelines as an artefact. Design Science Research proved to be a comprehensive tool in exploring issues related to Elluminate implementation.

Implementation of Elluminate in Learning Environments Evaluation using Design Science Research Framework

The research has provided an overview of Elluminate affordances implemented in learning activities in higher education subjects in four case studies. This research has begun to fill a void in Information Systems adoption research and has demonstrated that Design Science Research was a holistic evaluation framework to drive the research.

This research showed that three domains – Solution Technology Invention, Natural Evaluation and Theory Building – were useful in evaluating emerging technologies and could be used to categorise the impacts of emerging technologies in learning spaces. Solution Technology Invention focused on Elluminate affordances used in learning activities involved in a web session and described technology infrastructural constraints. Naturalistic Evaluation

focused on the evaluation of stakeholders' use of Elluminate in terms of easy-to-use without formal training and useful for learning activities, which included the beliefs related to the stakeholders' perspectives. Theory Building focused on the inclusion of suitable Elluminate affordances in the subject design which could assist academic developers and lecturers in achieving desired learning outcomes. The use of a constructive alignment approach enabled validation of curriculum design to deliver activities and assessments that support learning outcomes (Biggs 1996, 2002; Biggs & Tang 2007). Through the Design Science Research framework, the curriculum design evaluation considered the infrastructure and people involved in implementing an emerging technology in learning and teaching.

Understanding Web Interactive Multimedia Technology Affordances Use from Stakeholders

Each learning activity was designed to enable lecturers to facilitate the acquisition of knowledge and skills. Lecturers used the affordances of Elluminate for interaction with the students. The academic developers, lecturers and students expressed little difference regarding the constraints to effective Elluminate implementation. The main focus of academic developers related to their skill and knowledge on the implementation of technical issues. Lecturers looked at the delivery of subjects to students. The focus of students was interaction opportunities with lecturers and peers in order to create an appropriate and effective learning environment.

Multitasking

The findings from this research identified constraints to implementing Elluminate affordances in a university learning environment. This research found that, from the lecturers'

experiences, lecturing and texting at the same time was difficult. The multitasking action was nearly impossible because the focus was on the chain of thought during a lecture. Lecturers needed to focus on the mode of delivery in order to deliver the content effectively. The focus was intense in order to deliver a smooth lecture during a web session. In the literature review, reported in Chapter 2, this conflict of focus was not mentioned as a constraint in the Information Systems field but it has been studied in the context of texting while driving a motor vehicle.

Use in time

This research demonstrated that stakeholders used the available affordances in creative ways that helped to complete specific tasks in the allocated time of a web session. Time in a web session is limited and the lecturer needs to use Elluminate to provide an effective lecture or discussion to increase the students' learning. This can be seen in the use of an emoticon which was labelled on Elluminate as 'confusion' but was used to show disagree or dislike to get faster responses from students.

Class Size

The constraints on affordance choice and delivery depended on the number of students and the level of interaction required in a web-based class. Stakeholders faced fewer constraints with respect to affordance choice with a small number of students in a web session. In Case 1, the number of students in a web session was less than the number of allowed simultaneous speakers in Elluminate. The higher the number of students and the greater the requirement for interaction, the more constraints are faced, but it is possible to mitigate the constraints by managing the interaction and organising the number of students into small groups. In a low

level of interaction session, fewer affordances are used and therefore should lessen the focus on affordances in a web session. With the larger number of students in Case 4, audio was limited to three speakers at any time to make the interaction between lecturer and students more effective.

Elluminate audio and text affordances that supported high levels of interaction were found to be easier to use when the number of students in a class was small. Lecturers described the difficulty of multitasking in using dual affordance supported communication styles simultaneously. The lecturers could not give a talk using audio and write using text at the same time.

Technology Affordances Easy-To-Use and Useful

Elluminate was considered easy-to-use maybe because the stakeholders were already familiar with using technology on a daily basis. It seems that the adoption of Elluminate in a university was perceived as useful and easy-to-use. Other aspects were the value of the affordances that are better for learning and the perspectives of the stakeholders which reflect their attitudes and beliefs.

Designing Subject Delivery

In this research it was found that idiosyncratic or individual attitude, as well as any affordance being useful for a purpose, impact on adoption decisions. Elluminate provides opportunities for interaction in a virtual space where geographical physical distance between participants is unimportant. However, it was found that problems with technical infrastructure were

sometimes a hindrance to adoption decisions, even when the technology affordances were considered easy-to-use and useful.

Biggs (1996) and Biggs and Tang's (2007) theory of constructive learning highlighted the importance of the design of a subject whereby lecturers ensure that the learning activities align with assessment tasks. Technology affordance choice was seen to ideally sit within the subject design phase to ensure that affordance choices augment collaboration and open access to information learning activities.

This research demonstrated that academic developers and lecturers agreed that the use of Elluminate should be designed subsequent to the design of learning activities and assessments but during the subject design phase. The academic developers and lecturers considered the learning objectives as the most important component of subject design. Technology choice was secondary to curriculum decisions and always aimed at supporting learning activities that deliver appropriate knowledge and skills. Technology choice was an option to be used to facilitate lecturer-student and student-student communication and collaboration.

6.2 The Guidelines to Subject Design

When Elluminate was implemented in higher education institutions, the affordances brought many opportunities to facilitate learning across physical geographical boundaries. The range and diversity of subjects taught in higher education provide a myriad of learning activity and assessment delivery choices to meet the needs of staff and students. The choice of affordances can become a burden. The artefact developed as an outcome of this research facilitates decisions about affordances. The guide assists affordance choices once the lecturer has

designed learning activities and is aware of the technologies available. The affordances in Elluminate are also available in other Web 2.0 applications, either in partly or in total. Lecturers using those applications could also use the guide when designing the subject design to make the best use of the affordances in learning activities according to the group size of the students.

Several software applications provide web interactive multimedia technology affordances that could be used in a university learning environment. For example, audio to provide lecture to students is available in Skype and Yahoo Messenger. Stakeholders highlighted the need for guidance, especially for lecturers who would like to implement an application and its associated affordances for the first time. This research has developed guidelines to assist lecturers' decision making during subject design. It maps the best use of each affordance in learning activity with regards to the level of interaction and the size of the group of students. The guidelines are similar to a recipe where a lecturer can improvise on the guide to suit a particular subject or a particular software application provided by the infrastructure of the university. With the guide, the lecturer can benefit from the experiences of early adopters.

6.3 Contributions of the Study

This study extended the theory of technology adoption through the use of a Design Science Research approach, which provided a holistic view of the evaluation of the implementation of Elluminate in higher education. The affordances of used in learning subjects in a university learning environment in real settings were explored. The affordances were evaluated in terms of ease-of-use and usefulness (Davis 1989; Rogers 2003). The implementation of subjects was also assessed according to Biggs' constructive alignment principles (Biggs 1996, 2002;

Biggs & Tang 2007). Guidelines to assist lecturers to make decisions about subject design were produced as an outcome of this research using the Design Science Research in Information Systems approach (Venable 2006a). The guidelines as an artefact is in accordance with utility theory that assists in making decisions about subject design (Venable 2006b).

This research suggests that the stakeholders use technology for facilitating learning activities in universities. The artefact derived from this research provides a conceptual tool to aid lecturers to achieve the intended learning outcomes within the limited time of a web session. Technology can change the world without the knowledge of the stakeholders (Postman 1992). Research commonly focuses on how a technology can help a society but Postman (1992, 1994) focused on another perspective, where a new technology changes the meaning of many words and can change behaviour such as how ideas are taught in schools or used in the workplace. From this research, it is clear that the stakeholders still regard the technology as a tool but the way the technology is used may either change from the traditional approach or just continue with the same style. A lecturer could use the emerging technology to provide a one-way didactic lecture or use it for two-way interactivity with the students. The traditional setting of lecturers and students in a face-to-face platform has changed to a screen with affordances for learning.

The general findings of this research contribute to the understanding of the implementation of affordances in learning activities and the design subject delivery based on the case studies evaluated. The artefact is a set of guidelines for adopting affordances based on evaluations of the implementation, constraints and stakeholders' perspectives of the affordances, and learning alignment. The importance of Design Science Research is that it contributes to filling

the gap between design and implementation and provides a way of discovering solutions to technology problems. To ensure that web interactive multimedia technology affordances are implemented effectively in learning, the artefact provides a conceptual guide as a basis for lecturers who use during subject design. Lecturers are creative when designing subject delivery and the artefact is a guide to aid difficult decision-making choices. The methodology, analysis and outcome of this study support the value of the Design Science Research framework.

This research contributes to the understanding of training and support needed by a lecturer in order to adopt Elluminate successfully. From this study, formal training that focuses on how to make the technology function was not deemed important. In the main part, stakeholders were already familiar with web multimedia affordances as they used technology to perform daily tasks. They did not need training on how to use the affordances of an application. However, academics needed assistance to adopt applications and to make full use of the affordances, in order to achieve intended learning objectives. This sometime required re-design of learning activities and assessments.

This research shows that individual constraints may contribute to resistance to the adoption of an emerging technology, in learning environments in higher education institutions. However, this research does not focus on investigating organisational culture and the impact of cultural attitudes on the adoption of emerging technologies. The higher education institution sometimes implements a technology system and expects lecturers to adopt it in their learning activities in ways that suit them. The impact of top-down implementation of technology which requires operational level mass changes to standard process was not the focus of this research. Often, the institution provides freedom of choice in relation to adoption. From an

organisational perspective freedom of choice can be seen as a failure in investment, as a system such as Elluminate has licence fees that a higher education institutions needs to maintain to continue to provide that service. However, an artefact developed is intended to assist academics who are required to adopt new technology.

An artefact, a guide for web interactive multimedia is proposed as a conceptual tool to aid and support lecturers' decision making in designing subject delivery. The technology affordances may be available in other Web 2.0 technologies. For example, text is found in Facebook and Twitter, and audio and video are available in YouTube and Skype. In addition to providing a tool to augment activity delivery decision-making during subject design, this study has provided an awareness of available technology affordance choices.

6.4 Suggestions for Future Study

It is noted that the study might have been able to provide the university perspective if it had been possible to interview more stakeholders in more universities. However, given that the learning context is made up of a network of players, it was impossible to interview representatives from all groups and capture all perspectives. The participants in this study were the most important stakeholders at the time as they were early adopters and acted as a catalyst for others adopting the technology and implementing it successfully. Further, the goal of this research was to obtain rich data on participants' experiences in using Elluminate affordances; hence, the responses provided by the academic developers, lecturers and students were considered to be sufficiently informative. As the enthusiasm of the participants increased during the interviews, which caused the interviews to divert to other related matters, it was difficult to ask the participants to adhere to the interview protocol. This is a challenge for

most exploratory research as it requires skills for the researcher to keep participants' enthusiasm focused on the interview questions and not be diverted to non-related issues. Nonetheless, the information provided was useful for data analysis as it provided insight and facilitated an in-depth analysis. The extent to which the responses converged towards a common set of themes and issues was informative, and some unexpected themes emerged. In terms of the study as a whole, it predominantly took shape in and through the interpretive work with the qualitative methodology in the Design Science Research approach.

To advance research in the Information Systems adoption field and Design Science Research, this study conducted case studies on subjects implementing Elluminate affordances in the learning environment. Given the growing focus globally on Information Systems as a means to effect and enable learning delivery, it is of paramount importance to further investigate web interactive multimedia technology affordances. In order to understand this process more fully, it is essential that future studies build on the findings of this research. The next step for implementation research is to carry out more investigation to examine in greater detail specific affordances, constraints to adoption and other learning contexts to provide more insights into the implementation of web interactive multimedia technology affordances. Research that provides implementation guidance and ensures fewer technical problems could create positive experiences with the use of emerging technologies, which should reduce the number of people in Postman's (1992, 2004) change resistant third group. The proposed model for learning for this study may be useful to apply in other areas. A desirable outcome of this study would be that researchers are encouraged to conduct similar studies and adapt web interactive multimedia technologies accordingly as well as testing the guidelines, an artefact for decision making support.

Multiple case studies carried out in various subjects in various universities are suggested to further improve the generalisability of the findings. The stakeholders' appropriation of particular affordances in a given environment could be evaluated and used to predict further use in similar contexts using alternative software applications containing similar affordances. This research could also be extended to other Web 2.0 technologies looking at how the affordances are being used in learning activities. Given the growing significance of Information Systems in enabling global learning, the role of web interactive multimedia technology affordances for effective learning needs to be further addressed by more research in this area. In order to understand the key processes more fully, it is recommended that future studies build on the Design Science Research approach as used in this research, as it is a holistic approach and demands a utility that improves process, product or service (Venable 2006b).

This study has demonstrated that web interactive multimedia technology affordances have the potential for improving learning activities. However, further research needs to be conducted on the impact of the emerging technology on learning. Further investigation in more organisations in different learning sectors and cities may provide more insights into the affordance use, culture and belief on the adoption and implementation of an emerging technology. There may be departments or units which are viable within the university environment and which have characteristics and values conducive to change and innovation. Future research is needed on the roles of culture and belief, which may influence the organisational culture in higher education institutions as a governing domain, and which are known to be resistant to radical change. Such investigation could also expand the research to other countries in the Asia Pacific region that have adopted and implemented web interactive multimedia technology successfully, despite the differences in culture and its major indicators

such as language and religion. Such studies could also benefit from exploratory investigations into the variations within the different social cultures of the region.

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Appendix I

Ethics Approval

RMIT UNIVERSITY

RMIT University

GPO Box 2476V
Melbourne VIC 3001
Australia

Tel. +61 3 9925 1408
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www.rmit.edu.au

Ref: Ethics Appl. 1000215

Wednesday, October 20 2010

Asma Md Ali
13 Vale St
Reservoir
Vic 3073

Dear Asma

I am pleased to advise that your application for ethics approval for a Research Project has been approved by the Chair of the Business College Human Ethics Advisory Network. Approval has been granted for the period from 19 October 2010 to 20 September 2013.

The RMIT Human Research Ethics Committee (HREC) requires the submission of Annual and Final reports. These reports should be forwarded to the Business College Human Ethics Advisory Network Secretary. Annual Reports are due in December for applications submitted prior to September the year concerned. I have enclosed a copy of the Annual/ Final report form for your convenience. Please note that this form also incorporates a request for extension of approval, if required.

Best wishes for your research.

Yours sincerely

Kristina Tsoulis-Reay
Secretary
Business College Human Ethics Advisory Network

Encl.

Appendix II

Sample of Invitation to Participate

INVITATION TO PARTICIPATE IN A RESEARCH PROJECT

PROJECT INFORMATION STATEMENT (ACADEMICS)

Project Title:

Evaluation on the Web Interactive Multimedia Technology in University: An Exploratory Study.

Investigators:

Asma Md Ali (Student, PhD in Information Systems, Business Information Technology and Logistics)

Dr Joan Richardson (First Supervisor, Business Information Technology and Logistics, RMIT University, joan.richardson@rmit.edu.au)

Dr Peter Macauley (Second Supervisor, Business Information Technology and Logistics, RMIT University, peter.macauley@rmit.edu.au)

Dear Sir/Madam,

You are invited to participate in a research project being conducted by RMIT University. This information sheet describes the project in straightforward language, or 'plain English'. Please read this sheet carefully and be confident that you understand its contents before deciding whether to participate. If you have any questions about the project, please ask one of the investigators.

Who is involved in this research project? Why is it being conducted?

The research is being conducted by Asma Md Ali (student), Dr Joan Richardson (first supervisor) and Dr Peter Macauley (second supervisor). The research is being conducted as part of Asma's PhD in Information Systems at RMIT University. The research has been approved by the RMIT Business College Human Ethics Advisory Network.

Why have you been approached?

You have been approached to participate in this research because you are a lecturer at RMIT University using Elluminate to teach a course. The researchers wish to obtain your feedback with respect to the impact of the use of Elluminate on teaching and learning. It is hoped that this will provide us with more information about the research topic.

What is the project about? What are the questions being addressed?

The research will be evaluating the use of Elluminate in teaching and learning at RMIT University. The project will involve lecturers and students at RMIT University city campus. It is hoped that two lecturers and twelve students will participate in the study.

If I agree to participate, what will I be required to do?

Project participants will be required to attend an interview session. The participants will be interviewed by the researcher.

What are the risks or disadvantages associated with participation?

There are no foreseen risks with participating in this project.

If you are unduly concerned about your responses to any of the questionnaire items or if you find participation in the project distressing, you should contact *Dr Joan Richardson* (joan.richardson@rmit.edu.au (03) 99255804) as soon as convenient. She will discuss your concerns with you confidentially and suggest appropriate follow-up, if necessary.

What are the benefits associated with participation?

There are no direct benefits with participating in this research.

The indirect benefits will include the potential to influence:
- Technology use in teaching and learning
- Improvement in technology implementation
- Research and associated improvement in the university sector

What will happen to the information I provide?

The information collected will be confidential i.e. participants will not be identifiable in the research. All data collected will be stored in locked filing cabinets in the supervisors office at RMIT University and any electronic data will be password protected with access limited to the researchers. The research data will be stored securely at RMIT University for a period of 5 years upon completion of the project before being destroyed.

Any information that you provide can be disclosed only if (1) it is to protect you or others from harm, (2) a court order is produced, or (3) you provide the researchers with written permission.

The research will be produced as a student thesis for assessment. The research may also be published in journal or used at forum and conference presentations. The organization and participants will not be identified in any publications or forums.

The research will be made available to participants if they wish.

What are my rights as a participant?

Your rights as a participant include:
- The right to withdraw their participation at any time, without prejudice.
- The right to have any unprocessed data withdrawn and destroyed, provided it can be reliably identified, and provided that so doing does not increase the risk for the participant.
- The right to have any questions answered at any time.
- The right to request that audio recording be terminated at any stage during the interview.

Whom should I contact if I have any questions?

If you have any questions please contact Dr Joan Richardson, RMIT School of Business Information Technology and Logistics on 9925 5804.

Yours Sincerely,

Asma Md Ali
asma.mdali@rmit.edu.au

Dr Joan Richardson
03 9925 5804 joan.richardson@rmit.edu.au
Dr Peter Macauley
03 9925 5583 peter.macauley@rmit.edu.au

Any complaints about your participation in this project may be directed to the Chair, Business College Human Ethics Advisory Network, College of Business, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 5598 or email address rdu@rmit.edu.au. Details of the complaints procedure are available from http://www.rmit.edu.au/browse;ID=2jqrnb7hnpyo

Appendix III

Sample of Participant Consent Form

RMIT BUSINESS COLLEGE HUMAN ETHICS ADVISORY NETWORK

Prescribed Consent Form for Persons Participating In Research Projects Involving Interviews, Questionnaires, Focus Groups or Disclosure of Personal Information

COLLEGE OF	**Business**			
SCHOOL/CENTRE OF	**Business Information Technology and Logistics**			
Name of Participant:				
Project Title:	**Evaluation on the Web Interactive Multimedia Technology in University: An Exploratory Study**			
Name(s) of Investigators:	(1)	**AsmaMd Ali**	Phone:	9442 4467
	(2)	**Dr Joan Richardson**	Phone:	9925 5804
	(3)	**Dr Peter Macauley**	Phone:	9925 5583

1. I have received a statement explaining the interview/questionnaire involved in this project.
2. I consent to participate in the above project, the particulars of which - including details of the interviews or questionnaires - have been explained to me.

I authorise the investigator or his or her assistant to interview me or administer a questionnaire.

I give my permission to be audio taped: ☐ Yes ☐ No

I give my permission for my name or identity to be used: ☐ Yes ☐ No

6. I acknowledge that:

Having read the Plain Language Statement, I agree to the general purpose, methods and demands of the study.

I have been informed that I am free to withdraw from the project at any time and to withdraw any unprocessed data previously supplied.

The project is for the purpose of research and/or teaching. It may not be of direct benefit to me.

The privacy of the information I provide will be safeguarded. However should the information of a private nature need to be disclosed for moral, clinical or legal reasons, I will be given an opportunity to negotiate the terms of this disclosure.

The security of the research data is assured during and after completion of the study. The data collected during the study may be published, and a report of the project outcomes will be provided as part of my PhD thesis. Any information which may be used to identify me will not be used unless I have given my permission (see point 5).

Participant's Consent

Name: _____ Date: _____
(Participant)

Name: _____ Date: _____
(Witness to signature)

Participants should be given a photocopy of this consent form after it has been signed.

Any complaints about your participation in this project may be directed to the Chair, Business College Human Ethics Advisory Network, College of Business, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 5598 ore-mailaddressrdu@rmit.edu.au. Details of the complaints procedure are available from http://www.rmit.edu.au/browse;ID=2jqrnb7hnpyo