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Improving mathematics education in the Middle East: a focus on technology, learning design and professional development

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Improving mathematics education in the Middle East: A focus on technology, learning design and professional development

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Certification

I, Bothaina Bukhatwa, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy in the School of Mathematics and Applied Statistics, University of Wollongong, is my own original work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Bothaina Bukhatwa
2014

Dedication

This thesis is dedicated to my parents, who are the inspiration for my life, for their love, endless support and encouragement.

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Abstract

This research is motivated by the challenges faced in the best design of eLearning sites to increase student understanding of educational processes and in providing appropriate professional development to academic staff. The particular focus in this research is *"How can tertiary mathematics education in Middle Eastern countries, specifically Libya and Oman, be enhanced through the integration of technology into teaching and learning?"*

The researcher, of Libyan origins was immersed in the Australian culture and education system, working sometimes as a research assistant engaged in the development of learning materials, and research student conducting evaluations, and interviews with staff and students and through these activities creating an environment that facilitated reflection on the similarities and contrasts between the education system in different cultures. Both qualitative and quantitative methodologies were used, with analysis of literature, surveys, focus groups and interviews as the primary methods of collecting data. Data collected were used to examine what is possible in the western context and in parallel to identify current education issues in Libya and Oman. The initial analysis of literature was undertaken with a view to identifying high functioning technologies that are free or low cost for use in Libya and Oman. This review was followed by two case studies conducted at the University of Wollongong (UOW), Australia, which were used to identify best practices with these technologies leading to a third case study that both explored professional development and implemented a professional development program at Sultan Qaboos University (SQU) in Oman.

Case Study 1 involved the researcher working with a lecturer at UOW, to improve outcomes of an introductory subject. The process for improvement drew on both lecturer and a total of 210 students' evaluations survey gathered over three implementations of the subject. The first step evaluated the effectiveness of existing resources. The next step saw the development of an improved way to combine resources so that students could better visualize and understand the learning process. This required the alignment of resources, supports, activities and assessment with learning outcomes. From this practices were determined that could benefit Middle Eastern classrooms. These included the use of eLearning site, video technology,

Tablet PCs, and the provision of online learning support.

Case Study 2 started with interviews with academic staff and postgraduate students in the School of Mathematics and Applied Statistics (SMAS) at UOW. This showed that software packages were primarily learnt through self-learning. Mapping of subjects taught by SMAS and in Libya suggested that the introduction of technologies such as eLearning site and Tablet PCs in Libya would be useful. Scope to use alternative freeware or low cost mathematical software was also identified. Other useful technologies identified included Cam Studio and PowerPoint, for the production of video resources, and Moodle, to manage the online learning environment.

Although the learning of mathematics software at UOW was undertaken primarily by self-learning, support was considered necessary for learning to use non-mathematics related technology such as required for video creation. Staff also needed ongoing technical support. Several units at UOW facilitate improvements in faculty teaching. Professional development at an institutional level was found to be more complex and multilayered than theories suggested. Many strategies and approaches are used in staff development including learning and sharing from each other's experiences, collaborating, project work, reflection, workshops, conferences and video conferencing. Face-to-face training sessions took a variety of forms including drop-in sessions, one-to-one consultations and group sessions. These methods are usable in developing countries.

The final case study followed the development of a professional development program to introduce staff to new technologies. This involved: 1) identifying the needs of staff in relation to technology; 2) organizing a system for communicating with staff targeted for professional development; 3) provision of workshops, including the need for evidence based evaluation to guide change; 4) the provision of a plan developed for staff to start the development process; 5) a time period for implementation, and 6) a follow-up to determine if implementation ensued.

The workshops were to be delivered in Libya. As a consequence of the civil war they were transferred to SQU in Oman. Staff and postgraduate students from the Department of Mathematics and Statistics (DOMAS) at SQU were surveyed. This

revealed that staff needed training both in how to use software and in how to integrate technology into curricular activities. The need for proper technical support was highlighted.

At SQU staff from a variety of departments attended workshops to increase their awareness of the significance of technology for student learning outcomes. Data revealed 86% of attendees had a positive response to the training, with 91% reporting they had been given ideas about how to integrate technology into the classroom. One lecturer was selected for further study to examine the outcomes of the professional development in terms of integration the use of Tablet PC into their teaching from both student and lecture perspectives. As an outcome the lecturer was use a tablet PC to deliver lectures and to develop video resources for integration in the suite of resources made available to support student learning.

This thesis shows the importance of determining staff needs and raising awareness of the importance of ICT to support student learning. Staff need professional development regarding the integration of technology into students educational experience. The single most important issue identified was the need to develop policy to mandate the use of technology in teaching. DOMAS staff often stated that they could not commit to use technology unless required to do so. Departments need to deliberate and plan to integrate available technology into the curriculum.

Publications

The following presentations and publications have emerged from this thesis.

Paper in refereed journal

- Bukhatwa, B, Porter, A & Nelson, M (2013), "Video resources for supporting learning in mathematics rich disciplines: A teaching perspective", *ANZIAM*, (53),C606-C620, Presented at the EMAC 2011 The 10th Engineering Mathematics and Applications Conference, EMAC 2011, Conference at the University of Technology, Sydney, from 4th - 7th December 2011.

Paper in refereed conference proceedings

- Bukhatwa, B, Porter, A & Nelson, M (2010), "Emulating the best technology in teaching and learning mathematics: challenges facing Libyan higher education", conference Science, Technology, Engineering and Mathematics (STEM) in Education 26 & 27 November 2010 - Queensland University of Technology, Brisbane, Australia. Available in online proceedings at http://stem.ed.qut.edu.au/index.php/conference-proceedings.html#e

- Bukhatwa, B, Porter, A & Nelson, M (2011), "Experience with Change Evaluations suggests the need for better learning designs: one possibility for mathematics, Global Learn Asia Pacific (Global Learn) 2011:1 Global Learn Asia Pacific 2011--Global Conference on Learning and Technology. Available in online proceedings at http://www.editlib.org/?q=bothaina&search_publication=GLEARN&search_start_year=2011&search_end_year=2011&fuseaction=Reader.SearchResults

- Bukhatwa, B, Porter, A & Nelson, M (2011), "Exploring learning design in tertiary mathematics ". Presented at Volcanic Delta 2011, the Eighth Southern Hemisphere Conference on the Teaching and Learning of Undergraduate Mathematics and Statistics, to be held in Rotorua, NZ from 27th November to 2nd December 2011. Available in online proceedings at http://www.math.canterbury.ac.nz/~j.hannah/Delta11/VolcanicDelta2011Proceedings.pdf

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1. Introduction

In this chapter the following research question is posed: “How can tertiary mathematics education in the Middle East countries, specifically in Libya and the Sultanate of Oman (Oman), be enhanced through the integration of technology?”. With this chapter investigation of what is possible in terms of improving mathematics education through the use of technology commences; the educational theories of learning which are pertinent to this research are reviewed. A broad overview of the methodology is provided discussing, a series of three case studies. The methodological approach relies on identification of what is best practice in a developed nation with a view to identifying ways to capitalize on lessons learned through educational developments that have been tried and tested. The research seeks to identify ways to introduce these best practice technologies to staff and students in Middle Eastern nations. Frameworks for evaluation of the various components of the research are also introduced.

1.1 Investigating what is possible

Technology has the potential to improve student learning and to provide opportunities in teaching that were not previously available (Gulati, 2008). Technological development worldwide has encouraged academics to integrate technology into education to support all forms of learning (Ali, 2003). O’Sullivan and Samarawickrema (2008) highlight that teaching and learning experiences are successful when Information & Communications Technology (ICT) is used to develop interactive learning environments. The combination of the Internet, websites and eLearning systems provide new directions for education, facilitating students’ access to learning resources and their interaction with peers and teachers, allowing learning in their own time and space. It has enabled learners to access and interact with peers in ways not envisioned even a decade ago. Students in western classes have access to a wide variety of software expanding the possibilities for learning, with modern technologies showing their effectiveness in providing a new approach to mathematics education (Aminifar, 2007). These statements are particularly applicable to students in developed nations, not so for students in some developing nations. For staff in developing nations faced with limited professional development, little use of technology and limited resources to purchase technology it is difficult to

imagine what is possible (Gulati, 2008). Research suggests that an eLearning system is one solution to bridge the education gap (Ali, Hussain & Ahmed, 2011). However, there is an increasing and extensive awareness that the pedagogical and technical expertise of the teacher is extremely critical (Hennessy, Harrison & Wamakote, 2010).

Drawing from the advances of developed nations, this thesis aimed to find ways to bridge the educational gap, by skipping the long learning curves undertaken in western nations and introducing staff in developing countries to current best practices in education. This research investigates what is best practice in a developed nation, and in particular mathematics education with a view to identifying ways to capitalize on lessons learned through educational developments that have been tried and tested. The outcome would be to deliver an advanced starting position for staff and students in the developing nations of the Middle East who are beginning their exploration of what is possible.

1.2 Purpose and objectives

The purpose of this research is to identify ways to develop tertiary level mathematics and statistics capabilities in Middle Eastern countries. The efficient introduction of technology into developing countries of the Middle East is dependent upon the availability and accessibility of hardware, software and communications infrastructure. However, the real challenge for educationists is how to utilise the potential of ICT to complement the role of the teacher as an effective tool in supporting teaching and learning in a learner-centred environment, instead of within a more traditional pedagogy (Hennessy et al., 2010).

Instructional technology research in higher education is conducted for many reasons. For example, it may relate to the provision of access to higher education for people otherwise disenfranchised by traditional delivery systems or on finding innovative approaches to employing technology to enhance the quality of teaching and learning (Reeves, Herrington, & Oliver, 2005). All instructional technology research focuses on questions of how people learn and perform, especially with respect as to how learning and performance are influenced, supported, or perhaps even caused by technology (Reeves et al., 2005).

The introduction of technology to developing countries was undertaken with a view to improving mathematics learning and hence questions as to how students are taught and how they learn mathematics and perform in ICT rich environments need to be explored. In order to investigate best practice and what is possible it was necessary to develop an understanding of:

- the issues confronting Middle Eastern nations in terms of integrating ICT into education;
- theories of learning as they relate to the integration of technology into teaching and learning;
- best practices in using technology to create blended learning (face-to-face teaching combined with eLearning sites) such as:
    - the infrastructure, available in developed nations to enable the adoption and adaptation of eLearning;
    - the rationale, such as the desired educational outcomes for the selection of technologies and practices used in modern online mathematics learning environments.
    - the provision of, or the needs of staff for professional development in relation to technologies readily available, both generally and specific to mathematics.
- models appropriate for professional development of staff in the Middle East.

The research objectives examined ways to improve mathematics education through the use of technology and to identify ways to introduce these technologies into the Middle East. In particular, the intent is to:

- develop, trial and evaluate an effective template, or structure, for embedding mathematics learning support into eLearning site;
- adapt best practice, in terms of technology use as developed in an Australian context, to meet the needs of the Middle East;
- develop, implement and evaluate effective professional staff development processes for the use of technology in these developing countries.

1.3 Research questions

Through immersion, a term usually used in language teaching (Lyster & Genesee, 2012), of the researcher into the Australian educational system, a number of specific research questions and issues came into sight and these questions were developed and refined. The key characteristics of this immersion involved the researcher at times working as a research assistant developing student resources, being totally engaged as a research student interviewing students and staff, reviewing students learning materials, outcomes and learning experiences, all while the researcher responded to the sensation of being surrounded by a complete other reality to that experienced in her home culture from Libya. This process created an environment conducive to reflection as contrasts and similarities between cultures and education systems came into view.

The set of research questions articulated (refer, Table 1.1) served as a guiding framework for data collection and analysis, with various methods adopted to answer the questions posed. In order to answer the overarching research question *"How can tertiary mathematics education in Middle East countries, specifically in Libya and Oman, be enhanced through the integration of technology into teaching and learning?"* the questions posed were initially asked in two contexts, Australia and the developing country Libya, but were later extended to Oman.

Table 1.1 Research questions and issues

<table>
<tr><td colspan="2">Overarching research question
How can tertiary mathematics education in Middle East countries, specifically in Libya and Oman, be enhanced through the integration of technology into teaching and learning?</td></tr>
<tr><td>In the Australian educational context</td><td>In developing Middle Eastern countries</td></tr>
<tr><td>To examine best practices, it was important to firstly determine that the selected learning outcomes for the chosen subject were positive. This was undertaken through addressing the questions:
How effective is the selected subject MATH151 subject in terms of impact on students' confidence or perceived competency?
How effective are the offline resources and the online learning provided in terms of usefulness in helping students understand?
How effective is the design of the eLearning site in terms of its provisions of attributes such as clarity or good access to materials?
Can other potential improvements be identified that may lead to an improvement of mathematics education for these students?</td><td>To examine the possibility of introducing, technology along with effective practices to mathematics students in a developing country the following question was asked:
What is the current state of access to technology in a mathematics department in a developing Middle Eastern country? Especially, what is the access to computer laboratories, software, hardware and the Internet? How and why are they used?</td></tr>
<tr><td>To investigate in a broader context than MATH151 the practices in using technology the following questions were asked:
What technologies are being used? What functionalities of technologies used? How are they used? Why are they used?
What staff and postgraduate students require in terms of professional development in order to use these technologies
What do staff developers see as appropriate strategies for staff development programs?</td><td>Having identified technologies used worldwide via a literary review and a study of technology use in the Australian context the search for low cost or free alternatives that could be used in a developing country were addressed by asking the questions:
What technologies and functionalities can be introduced to a developing country for mathematics education from a technical/cost perspective?
Are there freely available open source equivalent technologies to those used in Australian universities that can be used in Middle Eastern countries?</td></tr>
<tr><td>In the terms of the provision of mathematics education development what strategies may be applicable to education in the developing country context?</td><td>How can professional development be used to introduce current technology to Libyan mathematics staff?</td></tr>
</table>

1.4 Approach and methodology

To answer the research questions involves the selection of a methodology through which data are gathered. There are several different research paradigms involving collection of quantitative or qualitative data or the combining of the two types of data. How data are collected and what type of data relates to the trustworthiness of those data and thereby the implications and findings drawn. Discussion and selection of the paradigm framing the study and the research methodologies is detailed in Chapter 3.

1.4.1 This study in brief

Two case studies were the basis of this exploration to build knowledge of best practices leading to the third case study: implementation of professional development in a developing Middle Eastern country (refer, Table 1.2). Through immersion in an Australian tertiary mathematics education context, the researcher in the first two case studies investigated mathematics education seeking to identify best practices in a department involved in mathematics education research. The researcher then sought to introduce some of these practices the Middle Eastern context through the trial of a professional development initiative (Refer, Case Study 3 and Section 7.3.1).

The first case study, the *Redesign of eLearning site*, examined in Chapter 4, involved redesigning an eLearning site for a first year service subject that is a mathematics subject designed for science students, namely MATH151. The choice of subject is described in Section 3.2.1. The redesign involved altering the structure of the pages and developing video learning support resources, which included orientation videos, and videos showing the process of solving mathematics problems. It also involved evaluating three successive cohorts of students to discover the effectiveness of learning designs used to combine learning resources, in terms of improved student learning outcomes.

Table 1.2 Case studies and the main methods of data collections

Literature review		
Australian context		
	Case study 1 Redesign of eLearning site of Math151 at the University of Wollongong (UOW)	**Case study 2** *Professional development for technology in mathematics education* at the University of Wollongong (UOW)
Objective:	To explore students' perceptions of the utility and efficacy of the subject eLearning site	▪ To explore the technologies used in Australian mathematics classrooms with the view to considering which might have relevance in the Middle East ▪ To explore student and staff capabilities to use the a variety of technologies and the forms of personal professional development that were used to develop the capabilities necessary to effectively use the a range of tools ▪ To discover aspects that might impact on the successful transfer of such practices to the Middle East context or other developing countries
Participants	Students at UOW	• Mathematics Academic staff • Mathematics Postgraduates students • General staff
Instruments	Survey for student in one subject (MATH 151) in 2010, 2011, 2012	▪ Survey Staff & Postgraduates at math department at UOW ▪ Interview math staff at UOW ▪ Interview staff from different professional development units at UOW
Theories	Learning: Behaviourism, Cognitivism, Constructivism, Connectivism	Professional Development: Kirkpatrick, Parry & Berdie Model (Section 1.6.2)
Outcomes	• Improved student satisfaction with the redesign • Learning activities become more efficient and less arduous for students • Identification of a number of technologies that could have benefit in Middle Eastern classrooms. • Identify needs for professional development to enable use of these technologies	• Selection of potential technologies • Selection of potential training approaches for application in Middle Eastern classrooms.

Developing countries context	
	Case study 3 ***Professional Development in the Middle East*** **SQU at Oman**
Objective:	• To trial various technologies with staff and students • Drawing on experiences and learning from the UOW context, to design a professional development program for supporting the introduction of technology in the Middle East. • To explore barriers and supports for technology use in classrooms in the Middle East • To trial and evaluate a series of professional development sessions to develop staff capability • To identify the potential of professional development through determining the impact of the sessions on subsequent practice in one classroom. • To identify the potential to transfer the sessions to other contexts through implementation and evaluation of professional development in Malaysia
Participants	• Omani and Malaysian Mathematics Academic staff, Mathematics Postgraduates students and General staff
Instruments	▪ Survey Staff & Postgraduates at math department at SQU ▪ Interview math staff at SQU ▪ Interview staff from different professional development units at SQU ▪ Evaluation of training at Sultan
Theories	Professional Development: Kirkpatrick, Parry & Berdie Model (Section 1.6.2)
Outcomes	• Reflection on the adequacy of professional development theories • Identification of factors impeding the achievement of optimal benefits from the technology applications in the learning

Remaining in the Australian context in Case study 2, *Professional development for technology in mathematics education,* discussed in Chapter 5, interviews were used to identify what technologies staff used, how they were used and the difficulties staff found in learning technology in terms of self-development and staff development. These were followed by interviews undertaken with staff involved in staff development to ascertain best practices for professional development.

The focus of the third case study, *Professional Development in the Middle East*, Chapter 6, involved introducing technologies to academic staff in developing Middle Eastern countries. This was preceded by an analysis of issues regarding educational technology in one Middle Eastern country, Libya. The insight into issues that led into the development of a professional development package for staff in Libya also allowed adaptation, implementation and evaluation of the professional development package in Oman.

The following section discusses the educational theories of learning that underpin the design and implementation of teaching and learning by academics.

1.5 Educational theories of learning

Gunn and Steel (2012) define theory "*as an organizing framework that brings an additional layer of understanding to concrete experience by implying relationship, consistency and a degree of predictability and testability*" (p. 8). Learning theories are commonly consulted in the instructional design process in many traditional educational settings (Mallon, 2013).

The case studies explored in this thesis, conducted at the tertiary level, involve adult participants, students, the learners, staff, and those engaging in professional development. Knowles (1990) argues that adult learners bring a great deal of experience to the learning environment and therefore the active participation of learners should be encouraged and acted upon when designing and implementing educational programs. Social constructivism emphasises the importance of social interactions in affecting the individual's generation of knowledge or facts about the world (Bell, 2011) and this is important for adult learning. Knowles (1990) identified six 'adult learning principles' which should be considered when designing for adult learning:

1. *Adults are internally motivated and self-directed*
2. *Adult learners like to be respected*
3. *Adults bring life experiences and knowledge to learning experiences*
4. *Adults are practical*
5. *Adults are relevancy oriented and*
6. *Adults are goal oriented. (p. 11).*

The researcher, through working with a variety of people and literature, encountered educational practices best described by different learning and teaching theories: behaviourism, cognitivism, constructivism, and connectivism, each of which has their own philosophical underpinnings. Consequently, in this thesis relevant theories are used to explain how an online eLearning site was designed, how students learnt and how professional development was conducted. A discussion of the relevant learning theories follows.

1.5.1 Behaviourism

Behaviourism is associated with stimulus and responses (Skinner, 1974). The learner is trained to respond based on a stimulus. Behaviourists concentrate their efforts on observable learner behaviour and reinforcement (Honebein & Sink, 2012). Behaviourists believe that a student has learned something by observing their changes in behavioural responses (Anderson & Elloumi, 2004; Baharun, 2012). This is an objective approach, where knowledge is perceived as facts that can be transmitted from teacher to student (Bell, 2011). There are implications for online learning from the behaviourist school (Ally, 2008). These implications include:

- students should be informed of the explicit online lesson learning outcomes;
- students must be tested to examine an individual student’s achievement level and to provide feedback;
- the learning materials should be sequenced appropriately to promote learning; and,
- students must be provided with feedback so that they can examine how they are doing and take corrective action if required.

Behaviourists’ strategies are relevant to this study in two ways. Firstly, when designing materials for an eLearning site, issues of specifying objectives, feedback and reinforcement are apparent. Secondly, with regard to professional development,

behaviourist theory is relevant when setting the goals of the training, practice and the observation. However, some educators argue that not all learning is observable and that there is more to learn than a change in behaviour (Ally, 2008).

1.5.2 Cognitivism

Cognitivism opens up the black box of the mind, regarding the learner as an information processor (Bell, 2011). Good and Brophy (1990) define learning from a cognitivist perspective as the acquisition or reorganization of cognitive structures through human processes and the storage of information. Cognitive theories focus on how learners process information (Cordeiro & Cunningham, 2013) with memory, motivation, abstraction, thinking and reflection, all playing a significant part in learning Ally (2008). As such, cognitivist approaches have provided a foundation for learner-centred education. Graphic organizers and note taking skills are examples of cognitive theories that are of particular importance for teaching (Cordeiro & Cunningham, 2013).

Several aspects of cognitivism are of importance when exploring online learning and hence of importance for the case study *The Redesign of eLearning*. For example, in cognitivism, the learner is seen to use different types of memory during learning. This means that the strategies implemented for online learning should allow students to perceive information in ways that facilitate transfer to working memory (Ally, 2008). Such strategies include: proper location of information on the screen; appropriate use of colour graphics and size of text; the packing of the information; and the mode of the delivery such as, audio, visuals, animation and video.

1.5.3 Constructivism

Vygotsky (1978) defined constructivist learning theory as the active construction of new knowledge based on a learner's previous experience. Constructivist theory suggests that students learn by actively constructing knowledge, comparing new information to previously learned information, thinking about and working through discrepancies and ultimately reaching new understandings (Cordeiro & Cunningham, 2013). Constructivists see learners as being active rather than passive (Ally, 2008). Constructivism is participant-centered and moves with the focus from the teacher to collaborative student work (Anderson, Annand, & Wark, 2005).

Constructivist learning theory with its focus on knowledge construction based on learners' previous experience is a good fit for eLearning (Harman & Koohang, 2005). Koohang (2009) suggests a model based on constructivist learning theory for promoting learning in eLearning environments. The model has three elements: the design of learning activities, learning assessment and the instructor's roles. Each of these is addressed in the first study, *The Redesign of eLearning*.

While both constructivist and cognitivist learning theories provide ample pedagogical practices for designing instructional opportunities, their underlying principles do not often intersect and may leave something to be desired (Mallon, 2013). As Ally (2008) argues "*what is needed is not a new stand-alone theory for the digital age, but a model that integrates the different theories to guide the design of online learning materials*" (p. 18). In this study, a combination of aspects from existing learning theories, behaviourism, cognitivism and constuctivism, along with the principles of connectivism has been adopted.

1.5.4 Connectivism

As summarized in Table 1.3 the theories of learning discussed thus far form the ingredients of the theory, which appeared as a successor, connectivism. Connectivism is a learning theory for the digital age (Siemens, 2005), that contrasts with behaviourism, cognitivism, and constructivism (Ravenscroft, 2011). The limitations of these earlier theories include their intrapersonal view of learning and their failure to address learning that is located within technology and organizations (Siemens, 2004).

In connectivism the starting point for learning occurs when knowledge is activated through the process of a learner connecting to and feeding information into a learning community (Kop & Hill, 2008). Learning is seen as a network phenomenon, influenced, aided, and enhanced by socialisation, technology, diversity, strength of ties, and context of occurrence (Tschofen & Mackness, 2012). As such, connectivism involves opportunities for peer-to-peer learning networks where learning occurs in short bursts driven by the needs and interests of the learners and where flexible learning activities encourage interaction between instructors and students and among learners (Mallon, 2013).

Table 1.3 Theories of learning

* Source: (Siemens, 2008, p. 11).

Theories	Behaviourism	Cognitivism	Constructivism	Connectivism
How learning Occurs	Black box- observable behaviour main focus	Structured, computational	Social, meaning created by each learner (personal)	Distributed within a network, social, technologically enhanced, recognizing and interpreting patterns
Influencing Factors	Nature of reward, punishment, stimuli	Existing schema, previous experiences	Engagement, participation, social, cultural	Diversity of network, strength of ties
Role of memory	Memory is the hardwiring of repeated experiences - where reward and punishment are most influential	Encoding, storage, retrieval	Prior knowledge remixed to current context	Adaptive patterns, representative of current state, existing in networks
How transfer Occurs	Stimulus, response	Duplicating knowledge constructs of "knower"	Socialization	Connecting to (adding) nodes
Types of learning best explained	Task- based learning	Reasoning, clear objectives, problem solving	Social, vague ("ill defined")	Complex learning, rapid changing core, diverse knowledge sources

In this theory there is a much more intense focus, compared to other learning theories, on the networked and shared (or sharing) experiences (Tschofen & Mackness, 2012).

Social media and emerging technologies are used to facilitate learning through providing opportunities for external learning situations that are not always available, or feasible, in face-to-face classrooms. Connectivism appears relevant to the delivery of the subjects in the *Redesign of eLearning site study*, as students were to connect to and use learning resources and to communicate via the eLearning site. It is also relevant in the study *Technologies in Higher Education* where academic staff use different technology for communication with each other and for self-professional development.

1.6 Evaluation framework

Exploration of issues important for successfully improving education requires appropriate evaluation. However there are different perspectives, depending in part on the purpose of the evaluation, as to what the evaluation should focus on and how it should be undertaken. This thesis was prompted by the challenges posed by an

increased demand for information and interaction on university subject websites including providing high quality resources. It also addresses the challenge of increasing lecturers' knowledge and awareness as to how to best make resources available to support students enrolled in mathematics subjects and to apply this knowledge in a developing Middle Eastern country. Only research and evaluation can confirm how best to use new technologies and to identify technological and other problems that need to be addressed (Lewis, Davies, Jenkins, & Tait, 2001). As Baharun (2012) argues "*[e]valuation is needed to provide valid evidence of the impact of technological tools, or innovations, on student learning of mathematics and statistics*" (p. 11) and as Alexander (1999) states,

> *Evaluation needs to be part of all stages of the development and use of ICT… Without effective, scholarly evaluation, even well designed innovations are unlikely to achieve wider dissemination, and the potential benefits of ICT for learning in higher education are unlikely to be realised. (p. 182).*

A number of frameworks have been devised to measure technology-based learning. Owston (2008) discussed the main evaluation approaches developed for general educational programs, including Tyler's early conception of assessing attainment of program objectives, decision-making approaches, naturalistic evaluation, and Kirkpatrick's four levels for evaluating program effectiveness (reaction, learning, behaviour and results). The evaluation model of Alexander and Hedberg (1994) provided an applicable framework for evaluation of the overall study, *Improving mathematics education in the Middle East: A focus on technology, learning design and professional development*, and case studies within the study, the *Redesign of eLearning site* and *Professional Development in the Middle East*, with evaluation at four stages of development and use (refer, Table 1.4): design, development, implementation, and institutionalisation.

The case studies, within this framework for evaluation, also involved evaluation to determine the impact of the implementation of each component of the overall study.

Table 1.4 Evaluation of Professional development in the Middle East

Phases	*Source of data for each stage of Evaluation in Alexander & Hedberg model*
Design	▪ Literature review to identify issues in Middle East education and possibilities in West. ▪ *Case Study 1 Redesign of eLearning site*: identification of eLearning site practices in Australia focusing on design, resources, activities and supports students learning to inform design of subjects in Middle East. ▪ *Case Study 2 Professional development for technology in mathematics education.* Identification of best practices, technologies used and techniques for professional development in Australia to inform professional development in the Middle East ▪ *Professional Development in the Middle East*: Identification through surveys of staff needs in relation to technology use in Middle Eastern countries. ▪ Interviews to identify strategies for professional development
Development	▪ Choice of topics determined from Case study 1 and 2. ▪ The preparation of professional development package.
Implementation	▪ Delivery of the professional development Middle East (Oman)
Institutionalisation	▪ *Professional Development in the Middle East*: Interviews and surveys of participants regarding the usefulness of the technology; ▪ One lecturer developed to the point of implementation of the professional development program. ▪ Issues in transfer explored. ▪ Request for and use of workshops in Malaysia.

1.6.1 Evaluation Case Study: Redesign of eLearning

The first case study provided an opportunity for immersion into the Australian educational context. It explored the *Redesign of eLearning site* with a view to improving student learning experiences. eLearning is already known to have influenced the field of teaching, training and development (Manochehr, 2006), with many universities using systems such as Moodle to provide communication and additional resources for students. There are claims that eLearning, or online learning as it is also known, can improve student learning if it is purposely planned (Oliver, 1999). However, there are also concerns that there is insufficient evidence to show that eLearning is an effective delivery mechanism (Manochehr, 2006). Furthermore, there are many new technologies in eLearning environments, such as blogs, wikis, podcasting, interactive pads and smart boards, videos resources and video conference, Tablet PC, Moodle / eLearning site and social websites, which have been used to support students learning. Even though academic staff have been willing to open up to the use of these technologies in their classrooms, the question to address is whether these technologies are effective in improving learning (Owston, 2008).

Along with concerns as to the effectiveness of different technologies, Hanson and Heller (2007) argue that the design of academic programs typically focus “on the disciplinary content of what should be taught” while other issues important for

success in courses, such as, "how students learn most effectively, how essential learning process skills can be nurtured, and, for first-year students, how the difficult transition from high school to college can be facilitated" are overlooked. The primary functions of models of eLearning site that have been developed to date have been to support course development as well as to support the design of teaching and learning processes (Franklin et al., 2004).

Evaluation is important in this thesis where a redesign of eLearning site is undertaken as part of the exploration of best practices. One challenge facing evaluators of technology-based programs is to design studies that can provide the feedback needed to enhance their design or to provide evidence as to their effectiveness in answering some of the pressing issues facing teaching and learning with technology (Owston, 2008).

The evaluation of the first case study consists of two types of evaluation: formative and summative. Formative evaluations focus more on process and feedback to determine the extent to which the program is operating as intended (Rovai, 2003). Summative assessment is collected at the end of a subject and becomes part of the formative process directing the subject design of the latter implementations (refer, Figure 1.1).

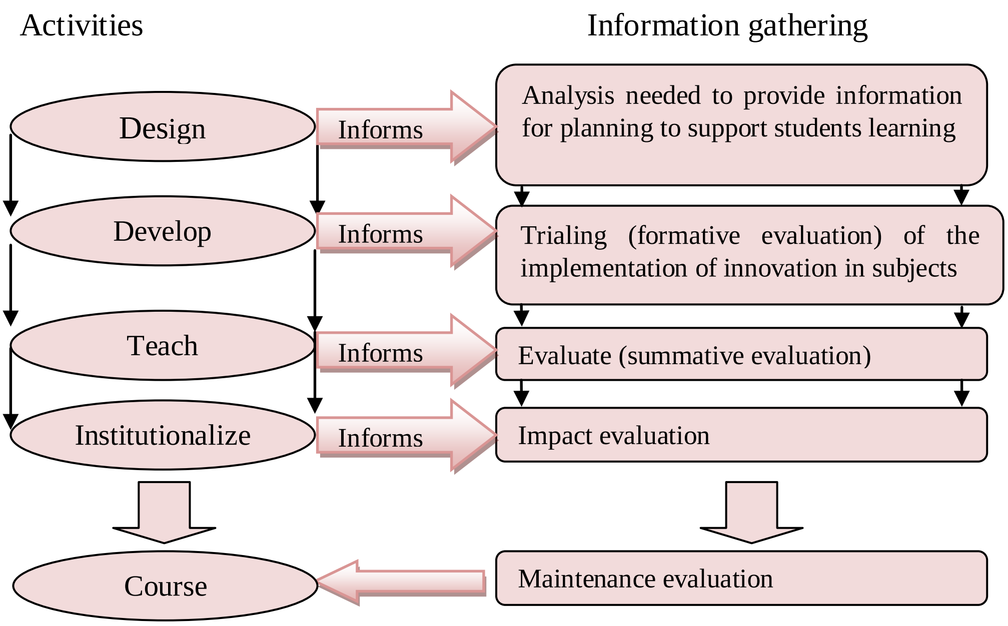


Figure 1.1 Activity and information gathering cycles

*Source: Adapted from (Alexander and Hedberg, 1994, p. 241)

The collection of evaluation data drew on the processes provided by two models: the Porter Change Evaluation Model (Porter, 2007) and the *Learning Design Evaluation Form* (Agostinho et al., 2002).

1.6.1.1 Porter Change Evaluation Model

Porter (2007) describes a change evaluation process for continuous improvement of subjects. This identifies areas of strength and weakness and thus allows targeting of subject areas where resources can be improved or replaced. Through baseline and follow-up evaluations the process provides a means of measuring the impact of innovations or modifications made to improve learning outcomes. The process involves *Next Step* interviews with academic staff and a *Change Evaluation* questionnaire for students. The *Next Step* interview is used to identify the resources used in subjects, for example lectures, tutors, video clips, assessment, the structure of the subject, the major topics taught, the learning outcomes desired together with the lecturer's perspective as to what needs to be changed in order to improve the subject. The *Change Evaluation,* completed by students, evaluates the usefulness of resources and the perceived attainment of learning outcomes, such as confidence.

1.6.1.2 Learning Design Evaluation Form

Agostinho, Oliver, Harper, Hedberg, and Wills (2002) proposed the use of a *Learning Design Evaluation Form* (ERF) to review learning designs prior to implementation. The ERF: *Learning Design Evaluation Form* (Agostinho et al., 2002) is a formative evaluation tool. The five areas examined are: 1) Whether the learning design supports learner engagement; 2) How well the learning design acknowledges the learning context; 3) Whether the learning design challenges learners; 4) Whether the learning design provides practice; and 5) Whether the technologies employed, their supportive systems and particular implementation facilitate the learning design. The focus of the evaluation of the learning design is to guide lecturers through the process of designing and planning learning to produce an effective learning design.

In this thesis this model is used to provide an evaluation of the different dimensions of *Redesign of eLearning site* than those measured by the Porter Change Evaluation Model.

1.6.2 Evaluation: Professional development

Evaluation is necessary to evaluate the effectiveness of the professional development of academic staff. Many lecturers do not use, or refuse to accept; technology for a number of reasons, such as poorly designed software, technophobia, doubting that technology improves learning outcomes, and fear of redundancy (Al-Senaidi, Lin & Poirot, 2009). Using evaluation results, program administrators can better understand how their program is working and where it is headed. The use of evaluation results enables them to make better decisions that will improve the program in the long run (Quiñones & Kirshstein, 1998). Harding, Kaczynski & Wood, L. (2005) argue that,

> *When we implement changes in learning, such as blended learning, we wish to judge the impact of the reform. Evaluation is a process by which we make judgments about the worth of an educational development (p. 56).*

The evaluation of professional development can be addressed through the lenses of a variety of models. The evaluation drew on components of two such models, but more closely aligned with the Parry and Berdie model.

1.6.2.1 Kirkpatrick model

Kirkpatrick (2006) suggests four levels for the evaluation of training programs. These are: reaction, learning, behaviour and results. *Reaction* refers to a measure of the program participants' satisfaction with the program; the quality of the training content and the trainer. *Learning* is the extent to which participants change attitudes, improve their knowledge, or increase their skills as a result of attending the program. *Behaviour* refers to the extent to which participants' behaviour changes as a result of attending the course. The fourth evaluation level, *results,* focuses on the lasting changes to the organisation such as increased productivity, improved management, or improved quality that occurred as a consequence of professional development.

1.6.2.2 Parry and Berdie model

In accordance with Parry and Berdie (2004), the development and delivery of the training includes the documentation of subject structures and evaluation of the program. This model contains seven levels with evaluation, regarding training effectiveness, conducted at each level. At the first level, the *Course level* evaluation is conducted to guide revisions and modifications to the training. The second level, *Satisfaction,* measures the trainees' feelings about the trainer, the quality of material

presented, the methods of presentation, and the environment. The third level, *Opinion*, refers to the trainees' attitudes toward utilization of the training, such as their perceptions of its relevance; the new material's fit with their prior belief system, as well as their perceptions of their own learning. Level 4, *Knowledge Acquisition*, refers to such activities as learning and recalling terms, definitions, and facts. Level 5, *Knowledge Comprehension*, includes such activities as understanding concepts and relationships, recognizing examples in practice and problem solving. Level 6, *Skill Demonstration*, requires the trainee to apply learned material in new and concrete situations. Level 7, *Skill Transfer*, focuses on evaluating the trainees' performance on the job. This requires the trainee to apply new knowledge and skills in situations occurring outside the classroom.

1.7 Conceptual framework

A conceptual framework has been defined as a 'the current version of the researchers map of the territory being investigated of the territory being investigated' (Miles and Huberman (1984, p.33). The initial assumption by the researcher guided by her reflections, the starting point for the research, was that in comparison to Australia, Middle Eastern mathematics classrooms used little technology and that its introduction to teachers would be of benefit. Alexander and Hedberg's (1994) evaluation framework with evaluation of 'all kinds of educational innovations', through four phases of evaluation provided a broad mapping tool. The first phase of design, a needs assessment, was to explore good practice in Mathematics in the Australian context through to the fourth stage examining in detail the issues in the Middle East where professional development was to be undertaken (refer, Table 1.5).

In accord with the philosophical approach adopted and self-positioning, holding the view that here are potentially multiple perspectives on any phenomenon an interpretivist approach was held. This approach encompassed the need to triangulate data, though a mixture of methodologies. The analysis of need in the design phase involved multiple methodologies, namely, literature review, artifact analysis, and an examination of current practice through interviews and surveys of staff and students regarding needs for professional development, together with an examination of models for effective staff development.

Table 1.5 Phase 1: Design Phase

Design (needs analysis): To identify what is best practice with technology in Mathematics in the Australian context so that this or similar practices could be introduced through professional development in the Middle East	
Method	**Sources of Evidence for triangulation**
Review Literature	The territories investigated involved the review of: ▪ Middle East challenges ▪ Effective technologies discussed in higher education in developed countries which can be used in developing countries such as open learning resources. ▪ Theoretical perspectives, Behaviourism, Cognitivism, Constructivism, Connectivism as a basis for describing and guiding what occurs to enhance learning in the classroom and professional development. ▪ The need for professional development in areas such as learning design for delivering learning support for students. ▪ This lead to paradigm selection, a pragmatic approach and the validation of outcomes through triangulation.
Analyse Artifacts	Thick description of people and settings was used to develop and convey an understanding of the context within which innovations had been used and were to be introduced. This included • eLearning sites at UOW(Chapter 4) in terms of the use of visual/ auditory material via eLearning site, the use of learning design ▪ Mapping software in Computer Laboratories and UOW subjects (Chapter 5) ▪ Identifying possibilities for adoption of technologies, mapping of a Libyan subjects (Chapter 6)
Examine current teaching & learning practices	The aim was to explore students' perceptions and experience of the utility and efficacy of the subject eLearning site. The evaluation of the effectiveness of learning resources and innovations to the eLearning website over three teaching cycles, examined various outcomes such as changes in confidence, ability to understand and learn, and performance.(Case Study 1)
Examine professional development need and practices	The aim was to determine which software required professional development to facilitate its use. This was accompanied by an examination of the different models used to professionally develop staff and aligning this to the contexts within which development took place (Case study 2).

Building on extensive needs assessment, the second phase relates to the development of the professional development package (refer, Table 1.6).

Table 1.6 Phase 2 Development of the Alexander and Hedberg model

Development: Production of the professional development package	
Method	**Sources of Evidence**

Development of the Instructional Material	This involved the
	▪ Documentation of design (Appendixes 1- 4)
	▪ Raising Awareness Workhsop
	  ▪ Topic 1 eLearning,
	  ▪ Topic 2 Learning design,
	  ▪ Topic 3 Evaluation,
	  ▪ Topic 4 Using a Tablet PC in lectures and for resource creation
	▪ Expert review and refinement

The first two stages lead to the implementation of the innovation, in this case professional development, and the success of that implementation is assessed in terms of evidence of key features of professional development programs as discussed by Parry and Berdie (2004), and Kirkpatrick model (2006), (refer, Table 1.7).

Table 1.7 Phase 3 Implementation of the Alexander and Hedberg model

Implementation	
Method	**Sources of Evidence**
Raising Awareness workshops	▪ Program implemented in Oman (During February to April 2012) ▪ Pre-interviews or surveys (design aspects but also preparation for the workshop) ▪ Raising Awareness Workshops ▪ Post workshop evaluation survey (designed to assess factors identified by Kirkpatrick model and Parry and Berdie (2004) models.

In terms of a conceptual framework, the fourth phase of the evaluation model shines light on the need to examine the extent to which the innovation is institutionalised in terms of the outcomes, transferability and sustainability. The innovation itself, the professional development package, by its very nature will only be sustained for a short while, until technology changes and staff need different development. In this study the examination of institutionalisation looked at the current applicability of the professional development, particularly Raising Awareness workshops, in two countries, the outcomes in terms of impact in one classroom and possible one-on-one mentoring continuing. Issues were also identified that would impact on the sustainability of the use of technology in the classroom in the Middle Eastern context (refer, Table 1.8).

Table 1.8 Phase 4 Implementation of the Alexander and Hedberg model

Institutionalisation: The impact of the innovation can be examined in terms of it outcomes, transferability and sustainability (Bain (1999).		
Criteria	**Purpose**	**Sources of Evidence**
Outcomes	To determine impact on development of generic capabilities	▪ Evaluation of impact on practice in one classroom. ▪ Mentored staff willing to train other colleagues.
Transferability	To determine the robustness of the learning and its transfer beyond the immediate context of the innovation.	▪ The professional development designed for Libya, was tested and evaluated in Oman (Case Study 3, Chapter 6) ▪ The professional development program was delivered and evaluated in Malaysia (Postscript, Section 6.4)
Sustainability	Issues identified that impact on sustainability	▪ Develop a policy to “move the institution” toward better practices in Oman. ▪ Evaluation and funding are required.

1.8 Thesis overview

The use and the impact of technologies differ in developed and developing nations. In order to know the possibilities and the challenges for improving mathematics education in developing countries, a literature review regarding current technologies for teaching and learning in mathematics is undertaken in Chapter 2, along with an examination of issues associated with improving education in the Middle East. This is followed, in Chapter 3, by a discussion of the selection of mixed methodology

involving three case studies that address the main research question *'How can tertiary mathematics education in developing Middle Eastern countries be enhanced through the integration of technology?'* In the following three chapters findings are presented with respect to firstly, Case Study 1: *Redesign of eLearning*. Secondly, Case Study 2: *Technologies in Higher Mathematics Education* involving the identification of technologies used in a good quality Australian tertiary mathematics department and investigation into methods of staff development, from staff learners' perspectives and from a professional developers' perspectives. Finally, Case Study 3: *Professional development in the Middle East*. In Chapter 7 there is a discussion of outcomes from the three case studies in order to improve mathematics education through the use of technology, in particular in the Middle East.

2 Literature review

This chapter provides an overview of the challenges facing higher education institutions in the Middle Eastern nations: political instability, lack of financial support, quality of higher education programs, level of scientific research and publishing, curricula, information and communication technology, and teacher training. It also highlights hardware and software technologies available in the West, identifying eLearning, Tablet PCs, video resources and associated enabling learning designs and changed pedagogical approaches to teaching and learning in mathematics at the tertiary level that may be beneficial in Middle Eastern nations. The need for professional development is also addressed together with models for its delivery.

2.1 Introduction

While the technological revolution has been reshaping the way that education is organized and delivered (Nawaz, Awan, & Ahmad, 2011)., and transforming the ways university services are delivered to students (Chhachha, Makhijani, Khushk., & Maher, 2013), the impact of technologies differs in developed and developing countries (Mardani, Arjmandi, Tavakkoli & Nazeri, 2011). The overarching research question in this thesis is *"How can tertiary mathematics education in Middle East countries, specifically in Libya and Oman, be enhanced through the integration of technology into teaching and learning?"* In order to answer this question the challenges and issues confronting developing Middle Eastern countries in providing quality education and indeed those experienced by developed countries when integrating technology into teaching are addressed. Educational developments and the associated integration of technology into mathematics teaching are related to teacher skills (Ertmer, 2005; Dawes, 2001, Ertmer, 2010; Bingimlas, 2009) and this in turn involves an examination of approaches to professional development.

New ICT applications have given rise to the term 'any time any place' (Oliver, 2002), a reflection of the flexibility possible when using ICT to support teaching and learning. In this chapter, following a discussion of challenges for the Middle East, technology tools such as the use of learning design to combine and organize resources in an eLearning site are explored followed by models for professional development.

2.2 The Middle East

According to the IMF (2010), of the 139 countries in the world there are 20 countries called the Middle East. These are all classified as emerging and developing countries (refer, Table 2.1).

Table 2.1 Middle East countries

Algeria	Kuwait	Saudi Arabia	United Arab Emirates
Bahrain	Lebanon	Sudan	Yemen, Republic of
Djibouti	Libya	Syrian Arab Republic	Oman
Egypt	Mauritania	Tunisia	Morocco
Iran, Islamic Republic of	Qatar	Jordan	Iraq

The Arab Region benefits from a number of similarities and opportunities, including a long rich history spanning thousands of years, strong cultural traditions, a common language, a large educated workforce, and the region sits atop more than half of the world's oil resources (Mirkin, 2010). In general, culture underlies and influences education values and learning styles in the classroom (Lemke-Westcott & Johnson, 2013). In a society as tradition-bound as the Middle East, cultural influences present another challenge to the education sector. Chen et al. (1999) argue "*An appreciation of the role of culture in education is essential as it leads researchers and teachers to a deeper and more valid understanding of the nature of student learning*" (p. 219).

The Middle East countries use the Arabic language as at least one of their official languages. The people are mostly Arabs and Berbers and most adhere to the Islamic religion, although there are some small Christian groups. Islam is a common cultural element shared by the majority of countries in the region although there are various sects, Ibadhi, and Sunni, Shiite which are often in conflict in some countries.

Religion has a tremendous impact on the culture. Islam has become increasingly influential in Arab cultural and political life and the management style of Middle Eastern managers (Tessler, 2002).Bakhtari (1995) has described Middle Eastern culture as:

- traditional, with family-oriented views placing special emphasis on family unity and coherence;
- valuing friendship and sharing all aspects of their lives with friends;
- consultative, with its origins in Islam people like consultation with others, particularly elders;
- individualistic in the context of their own culture;

- less participative, particularly in decision making with important decisions made only by high-level authorities; and,
- very conservative in risk taking, relying on intuition and instincts rather than data and procedures.

The home environment in the Middle East is considered the most important factor influencing student use of eLearning sites (Andersson & Grönlund, 2009; Wright, Dhanarajan & Reju, 2009). Families that are opposed to the acquisition of technological skills obstruct the use of eLearning sites (Mapuva, 2009) with cultural values playing a role in determining patterns of technology development, adoption, usage, and outcomes. (Leidner & Kayworth, 2006). Reflecting their own cultural backgrounds and values, faculty and students may have different learning styles and expectations and this discrepancy may result in a mismatch between teaching methods and students' learning styles (Lemke-Westcott & Johnson, 2013). Arabs generally have a double stance toward various Western innovations and technologies. While many believe that Arab societies need to adopt Western innovations, technology and science for advancement and progress, they feel uncomfortable with any Western values that might be associated with such adoption (Al-Kandari and Gaither, 2011). Many Arabs refuse any acculturation of Western values that might alter or negatively affect the social structures, status quo, and the morality of youth (Nydell, 2005).

As discussed in the following sections, the Middle East faces many challenges when improving education including political instability, the lack of financial support for education, the current quality of higher education, curricula, the low level of scientific research, the state of information and communication technology infrastructure, and the need for professional development. Meeting these challenges requires action including a more efficient use of available resources and the mobilization of additional resources to deal with an expected increase in demand for higher education (Aced, 2011; Wilkens, 2011).

2.2.1 Political instability

Political instability is a major challenge currently facing the Middle East countries. This thesis along with plans to explore professional development programs for university staff in Libya began prior to the Arab Spring and was completed after. The

Arab Spring began December 18, 2010 in Tunisia, and then flowed to other Arab countries with different outcomes.

Libya's lack of the maturity provided, by self-disciplined opposition movements and systems of *"political alliances, networks of economic associations, or national organizations of any kind contributed to an all-out civil war"* (Anderson 2011, p. 6). While Oman, the site of data collection for this thesis, has been a stable political, economical and social system under the leadership of Sultan Qaboos and has achieved remarkable progress in both economic and social fields (Al-Gharbi & Ashrafi, 2010).

One finding highlighted at this stage is that civil conflict in this case the Arab Spring has a profound effect on educational development. The researcher, advised against returning to Libya, was prevented from implementing the professional development program. Plans to return to Libya to implement a professional development program were put on hold. The insight into issues that led to the development of a proposed professional development package for staff in Libya was adapted and implemented in Oman.

2.2.2 Lack of financial support

The governments in most Arab countries serve as the primary, often the sole, source of funding for higher education, but the budgets allocated for education remain insufficient to meet the growing needs of higher educational institutions (Al-Rashdan, 2009). A lack of spending and self-financed educational support; a lack of other sources of funding to be spent on development projects to improve the academic environment; the low levels of marketing of their services, consultancies and applied research result in universities losing important sources of self-financing and all make development difficult (Issa & Siddiek, 2012). The enormous wealth possessed by some Arab countries has gone towards educating a fortunate few abroad, rather than financing the desperately underfunded universities attended by the rest of the population (Al-Rashdan, 2009).

Higher education in Libya is financed by the state. There are five private universities (EACEA, 2012). The Ministry of Higher Education and Scientific Research (MHE&SR) allocates an annual budget for each university according to suggestions

made by the universities and in accordance with criteria, such as the institution's population, current infrastructure, and needed facilities (EACEA, 2012). However, higher education institutions in Libya have inadequate financing and governance (EACEA, 2012) and an increase in financial support is needed to improve the academic level of students and faculty, to raise the excellence in teaching activities, scientific research and community service and to develop a culture of career ethics among university professors (Tamtam, Gallagher, Olabi & Naher, 2011).

In Oman the government covers operating expenditure, including tuition. Qualifying private universities receive a grant of RO 17 million for quality improvements directly related to the classroom and learning resources (approximately US$44,155,268) (Al Shmeli, 2009). Public higher education institutions disperse financial support to students to pay for accommodation and living expenses, books and supplies (Al Shmeli, 2009).

2.2.3 Quality of education

Another major issue confronting the Arab World is the poor quality of higher education programs (Issa & Siddiek, 2012). Most educational institutions rely on traditional methods in managing affairs and so doing ignore the concept of comprehensive quality management, which would be far more efficient than any of the traditional management methods (Al-Rashdan, 2009).

Three indicators of the quality of education in Middle Eastern countries gathered by the Global Competitiveness Report (2010-2011) are to do with availability of training in higher education, the quality of the educational system and the quality of math and science education. As reported in Table 2.2, with the exception of Bahrain, Lebanon, Qatar, Tunisia and the United Arab Emirates, Middle Eastern countries have low quality education. Libya, the intended site for data collection has the lowest rank of the Arab countries with a rank, 138 out of 139 for the quality of the educational system and is second last with a rank 113 for the quality of math and science education. This poor ranking by Libya is not unexpected as education policy in general in Libya and higher education in particular, focuses on quantity without quality (EL Harathi, 2012). Oman is better ranked than Libya with a rank of 43 out of 139 countries, for the quality of the educational system and 58 for the quality of math and science.

A Libyan Government decision in the late 1980s eliminating English from secondary schooling has ensured that a whole generation grew up with no exposure to the English language (Najeeb, 2013) and consequently learners are unable to translate available data and learning material for their benefit (Tamtam et al., 2011). Though English language teaching was resumed in mid 1990s, students had suffered through a lack of qualified teachers and limited curriculum (Najeeb, 2013). In 2005, English was recognised as the official second language of Libya (Najeeb, 2013).

Table 2.2 Ranking out of 139 countries quality of education

Middle East and North Africa Countries	Higher education & training 2010-2011		Quality of the educational system 2010-2011	Quality of math and science education 2010-2011
	Rank	Score 1-7	Rank	Rank
Algeria	98	3.59	117	84
Bahrain	44	4.64	38	44
Egypt	97	3.59	131	125
Iran	87	3.80	108	41
Jordan	57	4.32	55	53
Kuwait	83	3.87	88	89
Lebanon	48	4.57	16	7
Libya	95	3.63	138	113
Morocco	102	3.51	105	67
Mauritania	137	2.15	135	107
Oman	63	4.22	43	58
United Arab Emirates	36	4.80	27	26
Qatar	32	4.84	4	4
Saudi Arabia	51	4.55	41	49
Syrian Arab Republic	107	3.31	109	70
Tunisia	36	4.80	20	8

Data Sources: Global Competitiveness Report (2010-2011)
* Djibouti, Iraq, Yemen & Sudan were not surveyed

The *Webometrics Ranking of World Universities* (2013) indicates of the twenty best Arab Universities, one Omani university (Sultan Qaboos University 17th) is ranked in the top 20 in the Arab World. The best of the Libyan universities, Misurata University, ranks 28th in the Arabic rankings but 2825th in world rankings.

2.2.4 Level of scientific research and publishing

Another major issue in the Middle East is the need to improve the low level of scientific research (Issa & Siddiek, 2012). Abdel Rahim (2004) points out that ‘while developing countries comprise 80 per cent of the world’s population, only 2 per cent of indexed scientific publications come from these parts of the world’. Although the publication of scientific research is necessary to support the economic and social development of developing nations, there is limited scientific productivity in most

developing countries because they have little tradition of scientific research, with China, India and Iran exceptions to this (Meyer, 2008).

Al-Rashdan (2009) suggests the low level of scientific research in Arab universities is due to professors having few incentives to carry out research. For example, staff experience:

- *a lack of sufficient competition between faculty members to earn high positions through research and studies;*
- *a lack of sufficient backing by the governments for scholarly research;*
- *a failure in the research policy in universities and academic institutions providing no clear objective to serve the goals of the university or society, and hence the studies that are carried out are done without purpose (Al-Rashdan, 2009, p. 82).*

Staff also face continual threats of censorship, with most of the universities in the Arab world shifting from being places of development to becoming objects of policing, illustrated by the presence of intelligence services on campuses, and the consequent control that they exercise over the faculty and the student body (Romani, 2009).

Universities ranked with respect to the *number of articles they published* showed in 2004-2006 that for the Arab countries rankings were very low with only two universities in the top of 20 in the *OIC (Islamic Countries)*, with one from Egypt (Cairo University) and one from Kuwait (Kuwait University) (OIC, 2007). None were from Libya or Oman. The same report shows that Libya has a low production of articles, with 69 articles published during 2004-2006 while there were 568 articles published in universities in Oman over the same period. By comparison, the University of Wollongong, the site of the first case study, published nearly as many articles each year as were produced in the three year period by all universities in Libya (refer, Table 2.3).

Table 2.3 Research publications at UOW

Years	2010	2011	2012
Research Publications	1279	1258	1451

Data Source: http://www.uow.edu.au/planquality/statistics/keyuowstatistics/researchpublications/index.html

Reasons for the small production of articles are that universities do not always follow their strategic priorities to make scientific research paramount and they do not have development plans for technical support staff (Tashani 2009). The level of support offered to staff makes a difference with lecturers more motivated and committed

when they feel supported by their institutions (Andersson & Grönlund, 2009). Support, and specifically ICT support, is often lacking in developing countries, as the few available individuals with technical expertise focus on network infrastructure installation, operation, maintenance, network administration and security (Wright, et al.,2009; Sife, Lwoga, Sanga, 2007).

2.2.5 Curricula

> *Too often the curriculum in developing countries is rigid and overloaded, leaving little time for innovative classroom practices (Hennessy et al, 2010, p. 43).*

There are a number of issues to be resolved with Middle Eastern curricula. Since the university curriculum of Middle Eastern countries does not take into consideration what the students have already learned over the pre-university years, most of the scientific and epistemological components are new to students and are difficult to connect to what they have already learned (Al-Rashdan, 2009). There was (and still is) a need to design new curricula specifically for an eLearning setting (Andersson & Grönlund, 2009). As eLearning is different from traditional learning, the curriculum and pedagogical methods need to be modified to fit the eLearning setting (Andersson & Gronlund, 2009).

In Libya programs and curricula are developed and approved by faculties and universities, with a recent trend towards centralising the reform of programs and curricula. This aims to standardise about 60-70% of the content of all subjects at the university level (EACEA, 2012). Tamtam et al. (2011) recommend that higher education in Libya should develop curricula and learning program outlines and descriptors to ensure learners and teachers are well informed about the details of what they want to study in undergraduate and postgraduate programs. Libyan educational developers lack the experience necessary to develop curricula and pedagogies for eLearning (Rhema & Miliszewska, 2010).

In Oman, a mixed education sector includes local and foreign *Higher Education Institutions* (HEIs). Most of the HEIs have adopted foreign curricula with little effort made to develop local curricula (Baporikar & Ali Shah, 2012). The infrastructure and facilities are in line with developed countries but a professional approach to put them to best use is sometimes lacking. It has been observed that the foreign curricula of

Western universities used in HEIs are higher than the students' standards, with students unable to understand them even after the completion of foundation courses (Baporikar & Ali Shah, 2012). All programs, whether developed and awarded locally or through foreign providers must be licensed by *the Ministry of Higher Education* before accepting student enrolments. The process of licensure is currently undergoing a significant evolution from bureaucratic registration to being a peer-driven standards-based form of approval (Carroll, Razvi, Goodliffe & Al-Habsi, 2009). Although the strategies and rules are in line with the local requirements and are well defined there is lack of implementation. That is, the substance in terms of strategies, policies and rules is very much there but the spirit behind it seems to missing (Baporikar & Ali Shah, 2012).

2.2.6 Information and communication technology

Cullen (2001) argues that in developing nations, scientists, scholars and students in universities and schools along with ordinary citizens should have access to the Internet and that this access should include access to the more valuable information sources, indexes, full-text databases, and e-journals that are not included in the freely available information on the Internet. Without this ICT scientists and researchers in developing countries are excluded from knowledge that may be vital to agricultural, social and economic development.

Data from the *Global Competitiveness Report* uses two rankings, *infrastructure* and *technological readiness,* to characterize the state of information and communication technology and to examine ICT in countries throughout the world.

In terms of *infrastructure* in the Middle East countries such as Lebanon, Mauritania, Syria and Libya are ranked low, while Oman, Bahrain, United Arab Emirates, Qatar and Saudi Arabia have good rankings. For *technological readiness* in the Middle East, countries such as Algeria, Libya, Mauritania and Syria Arab Republic are ranked low, while Bahrain, United Arab Emirates, Qatar, Oman, Tunisia and Saudi Arabia have good rankings (refer, Table 2.4).

Table 2.4 Infrastructure and technological readiness of Middle East

Middle East & North Africa Countries	Infrastructure		Technological readiness	
	Rank / 139	Score 1-7	Rank	Score 1-7
Algeria	87	3.49	106	2.98
Bahrain	27	5.08	27	4.88
Egypt	64	3.97	87	3.32
Iran	74	3.75	96	3.19
Jordan	61	4.11	62	3.71
Kuwait	60	4.11	77	3.46
Lebanon	123	2.47	92	3.24
Libya	95	3.22	114	2.87
Morocco	67	3.85	75	3.49
Mauritania	122	2.52	132	2.55
Oman	33	4.94	59	3.79
Qatar	25	5.24	36	4.44
Saudi Arabia	28	5.07	42	4.17
Syria Arab Republic	105	2.88	111	2.92
Tunisia	46	4.50	14	5.19
United Arab Emirates	3	6.26	14	5.19

* Notes: Djibouti, Iraq, Yemen & Sudan were not surveyed.

Data source: Data amalgamated from report of the Global Competitiveness Report (2010–2011)

Comparing the period 2010-2011 to the period 2012-2013, Libya fell in both rankings. This is probably due to the instability of the government (refer, Table 2.5). Higher education in Libya is currently facing major challenges for increasing the use of IT in higher education institutions (EACEA, 2012). Prior to the conflict, computer laboratories were accessible for students in the majority of Libyan higher institutions,although, these lacked sufficient network facilities to provide Internet access for all students (Rhema & Miliszewska, 2010).

Oman has a better ranking than Libya with *technological readiness*. It either improved or remained constant over the periods, with Broadband Internet subscriptions increasing from 89 to 92/100 pop and Internet bandwidth, from 68 to 79 kb/s per user.

Table 2.5 Rankings of technological readiness

Technological readiness	Libya rank 2010–2011	Libya rank 2012–2013	Oman rank 2010-2011	Oman rank 2012-2013
Availability of latest technologies	96	125	57	46
Firm-level technology absorption	99	108	52	52
FDI & technology transfer	127	136	52	45
Individuals using Internet	116	103	51	37
Broadband Internet subscriptions/100 pop	110	100	89	92
Int'l Internet bandwidth, kb/s per user	109	82	68	79

Data source: Data amalgamated from two reports of the Global Competitiveness Report (2010–2011, 2012-2013)

These low levels of infrastructure and technological readiness are among many challenges to overcome when seeking to integrate technology into education. Several institutions in Oman need to increase the quantity of updated technologies, software

and equipment and specifically the new technologies such as intranet points and multimedia labs (Al-Musawi, 2007).

2.2.7 Trained teachers

Impacting on the quality of education is the capability of teachers and their pedagogical practices. There are difficulties in recruiting and maintaining quality teachers in many countries in the Middle East with poor pay, restrictions on conducting research and obstacles to publication all contributing (Wilkens, 2011). Teachers in developing countries are often unable to access new technologies, and where technology is available many lecturers either often lack appropriate training (Ali et al., 2011; Wilkens, 2011; Chibelushi, 2008) or lack the knowledge and skills to use technology (Fathurrohman, 2013). Teachers need more help to effectively integrate computers and Internet technologies into the classroom, aligning curricula, exams, and incentives with the educational outcomes to be gained (Henessey et al., 2010). The real challenge for education professionals is how to use ICT to complement the role of a teacher in the teaching and learning process as a learner-centred tool, instead of within a more traditional pedagogy (Hennessy et al., 2010). Quality teaching involves possession of knowledge and the ability to transfer knowledge, skills and attitudes to the learners (EL Harathi, 2012). Expanding capability will involve the professional development of teachers to overcome many of the challenges to integrating technology into the classroom. Thus one challenge facing the education sector in Libya has been to provide teachers with an opportunity to gain the necessary expertise in order to do this.

Two rankings are used to characterize the *local availability of research & training services* and the *extent of staff training* (refer, Table 2.6). In terms of the *local availability of research & training services* in the Middle East in 2012, countries such as Algeria, Mauritania, Syria and Libya and Oman are ranked low, while Lebanon, Bahrain, United Arab Emirates, Qatar and Saudi Arabia have good rankings. With respect to *staff training* in Middle East countries such as Mauritania, Syrian Libya, Iran Egypt and Algeria have low ranks while Tunisia Qatar Bahrain United Arab Emirates and Saudi Arabia have high ranks (Global Competitiveness Report 2010–2011).

One of the difficulties arising from poorly trained staff is that most Arab universities adopt a traditional education approach based on rote memorization of material without enabling students to be innovative and mix scientific knowledge with practical application (Al-Rashdan, 2009). Al-Rashdan (2009) further highlighted that students are not encouraged to take a critical analytical approach towards numerous problems in society, creating a spirit of student submissiveness and fear to voice their opinion.

Table 2.6 Availability of research & training services

Middle East & North Africa Countries	Local availability of research & training services	Extent of staff training
	Rank	Rank
Algeria	105	103
Bahrain	81	16
Egypt	64	112
Iran	74	132
Jordan	48	101
Kuwait	75	96
Lebanon	53	102
Libya	134	110
Morocco	60	87
Mauritania	135	138
Oman	85	45
United Arab Emirates	23	29
Qatar	71	19
Saudi Arabia	34	34
Syria Arab Republic	114	139
Tunisia	27	18

Data source: Data amalgamated from report of the Global Competitiveness Report (2010–2011), Djibouti, Iraq, Sudan & Yemen were not included in the survey

In Libya higher education does not have development plans for technical support staff (Tashani 2009). The level of support offered for staff makes a difference (Andersson & Grönlund, 2009). Lecturers are usually more motivated and committed when they feel supported by their institutions. Other research concurs that in Libya there is lack of the well-qualified and trained teachers required for building a generation of technically qualified students (Farrel & Shafika, 2007), even though academic staff in Libya are required to hold recognised Masters or PhD degrees (EACEA, 2012). According to international standards an evaluation of academic performance in the Libyan education sector is required in order to strengthen and improve its quality.

“In most of the [Omani] institutions faculty is expatriate with international experience and exposure” (Baporikar & Ali Shah, 2012, p. 16).

Most faculty do have PhDs in their subjects but due to student teacher ratios which are high, the hand holding which the local students need both in terms of subject input, language and academic behaviour does affect the quality of teaching and learning while lack of research support and the academic environment, language problems, communication and cultural aspects also have their bearing on the student-teacher relationship (Baporikar & Ali Shah, 2012, p. 16).

Given the diversity in faculty in Oman mixed teaching methodologies are used including case studies, project based learning, classroom teaching and assignment base methods (Baporikar & Ali Shah, 2012). Even so intensive systematic in-service training programs in Oman are considered a must for staff in areas of new education technology design, production, use, and evaluation (Al-Musawi, 2007).

2.3 Technologies in higher education

Educational technology involves the disciplined application of knowledge for the purpose of improving learning instruction and /or performance"(Spector, 2012, p. 10).

The rapid and continuing advances in ICTs have been driving the educational design of new technology-based learning environments in higher education (Brack, Samarawickrema & Benson, 2005). ICT provides a catalyst for rethinking teaching practice (Flecknoe, 2002); improving learning outcomes, enhancing and improving the quality of teaching and learning (Wagner, 2001; Garrison & Anderson, 2003). Using ICT for student support assists students to learn more effectively (Kirkup & Kirkwood, 2005). New technologies enable teachers to undertake administrative tasks more efficiently (Flecknoe, 2002).

The emergence of new learning technologies has coincided with a growing awareness and recognition of learning theories that suggest there are many problems and inefficiencies with conventional forms of teaching (Oliver & Herrington, 2003). Good practice in teaching mathematics with technology was identified by Thomas, Bosley, delos Santos, Gray, Yoon Hong, & Loh, J. (2007) as placing emphasis on mathematical ideas and concepts rather than on passing on operational thinking to students. That is: teaching concepts without sacrificing skills; presenting the bigger picture while developing the skills that are necessary to understand mathematical concepts.

A variety of technologies, as discussed in the following sections, can be used in higher education to enhance student learning. These technologies impact on how teaching and learning are delivered. Learning management systems can help administer and deliver courses facilitating blended learning, video conferencing and Access Grids allowing real time access to distant classrooms. New technologies facilitate resource creation, with tools including Tablet PCs and software for creating resources such as podcasts and videos, communication and interaction. Important components of teaching that are based on social learning are facilitated by social networking tools. Of particular interest to mathematicians is the interactive whiteboard (IWB) that allows the writing of text, in particular mathematical text, to be communicated in real time across the net or Access Grid. These tools allow a variety of delivery mechanisms to support teachers and students through the provision of resources, learning support, assessment, administration and by facilitating communication and collaboration. For example, Google Cloud allows several collaborators to work on one document rather than shifting the document by email between each other.

2.3.1 Online learning management systems

There are a variety of online learning management systems (LMS). These include Moodle, WebCT Vista, Blackboard Learning Space, NextEd and WIZIQ amongst others that function as both enterprise-wide and Internet-based systems. These are particularly important as a medium for delivery of teaching, whether that delivery involves a blended learning environment, with a mix of traditional and online teaching, online teaching or eLearning, the flipped classroom, or MOOCs.

Szabo & Flesher (2002) define LMS as,

> *Learning management systems are computer based database and presentation systems which manage the entire instructional program and learning progress of employees with respect to the competencies specified by the goals and objectives of an organization (p. 1).*

Universities are encouraging or requiring each subject to have a web presence. Some universities have policies and incentives to stimulate content development activities (Coates, James & Baldwin, 2005), as they have welcomed the capability of online systems to promote access to information and services for students. The systems provide mechanisms through which the university can administer courses and allow

university lecturers to manage materials and information for courses (Parker, Bianchi & Cheah, 2008). Moreover, it allows instructors and students to share instructional resources, to communicate with each other (Lonn & Teasley, 2009b; Martín-Blas & Serrano-Fernández, 2009), and to assess and support student learning (refer, Table 2.7).

These systems have the capacity to create virtual learning environments for campus-based students and are also being used to develop fully online virtual universities (Coates et al., 2005).

Table 2.7 LMS functions

Admininistration	Resources	Support	Assessment
• Automatic Enrolment • Restricted access • Customize • Copy course • Grade tracking • Grades monitoring participation • Announcements	• Lectures • Multimedia • Document exchange • Uploading files (e.g. Word docs, PowerPoint, audio files), linking to external web sites	• Communication • Collaboration • Allows zipping of course onto CDs for students & backup • SCORM compliant • Discussion forums • Synchronous chat • Course calendar • Blogs, Twitter, Wikis,etc	• Tests • Surveys • Quiz • Creating an assignment • Drop boxes for the collection of assignments • Submit & return assignments • Peer assessment • Grades

Data source: (http://elearning.uvic.ca/documents/doc_view/3-detailed-moodle-blackboard-comparison).

A study conducted by Lonn and Teasley (2009b) suggests that while both instructors and students value tools and activities for efficient communication best, both communication tools and interactive tools for innovating existing practices are also highly valued.

Moodle is of particular interest for developing nations as it is an open-source system, available with some free features and as such it can provide an initial solution for Middle Eastern nations. In 2013, Moodle had been translated into 78 languages, was being used in many countries and had 73.7 million users. Worldwide, Australia ranks 9 of the top 10 countries in registered sites (Moodle, 2013). One of the distinguishing features of Moodle is that it allows external products to “plugin”, that is they can be used within Moodle (refer, Table 2.8). Of particular interest to mathematicians is the ability to use LaTeX within Moodle to write mathematical script. Having plugins makes Moodle a very versatile system as instructors or institutions may configure the LMS to use preferred tools across a range of functions such as administration, resource provision, and assessment.

"Plugins" may be sophisticated packages in their own right, for example the open source freely available software Mahara which is an ePortfolio system that allows for the online collection of reflections and digital artifacts such as documents, images, blogs, resumés, multimedia, hyperlinks and contact information (Mahara, 2013). Moodle and Mahara may be configured to work together with a Single-Sign-On (SSO) solution (3rd Wave Media Ltd, 2013).When Moodle is the master application, users log into Moodle to access Mahara, in which case Mahara is behaving as a Moodle plugin.

Table 2.8 Examples of plugins available in Moodle

Areas of use	Tools	Functions
• Administration	Grid Format	A modular and visual course format. Hides all topics & creates a grid of icons (one for each topic) with short titles. Icons link to content from the corresponding topic.
• Administration	Collapsed Topics	An interchangeable topic or week based format that solves the issue of the 'Scroll of Death' when a course has many topics.
• Administration	GISMO	GISMO, a graphical interactive student monitoring & tracking system that extracts tracking data from an online course maintained with Moodle, & generates graphical representations for course instructors.
• Administration • Assessment	LAE Grader Report	Alternative to Grader report that scrolls vertically & horizontally without losing student columns or grade item header rows. Lots of additional enhancements.
• Assessment	PoodLL Filter	The PoodLL filter allows inclusion of widgets such as stopwatches & flashcards into HTML areas. It is a pre-requisite plugin for the PoodLL Repository, Poodll Online Assignment & Poodll Recording Question types.
• Assessment • Resources • Support	FN - Marking Manager	This allows teachers to grade assignments & forums within a single interface.
• Support	PDF feedback PDF submission	Allows a teacher to annotate & return PDF files that have been submitted by students. Teachers can add & position comments & draw lines & highlights onto the students' work, from within the browser.
• Support	Jmail	jmail is an internal mailing (aka internal email) tool for Moodle 2
• Support • Resources	Video file	Easy using video

Alternatively, Mahara as the master application involves users logging into Mahara to access Moodle whereby Moodle is behaving as a Mahara plugin.

Dashboards can also be used within Moodle and are useful in the provision of learning analytics. Podgorelec & Kuhar (2011) classified dashboards as having,

> *strategic, analytical and operational purposes: strategic purposes focus on high-level measures of performance and can include predictions, with static and simple gauges they enable quick access to the information needed for decision making; analytical purposes supporting data analysis providing rich comparisons, and detailed history overview; and, for operational purposes showing real-time data capable of attracting the user's attention if a measure falls outside given norm, (p. 112).*

Dashboards can be used to visualize the key performance indicators of students' performance and can be used as a tool for on-time detection of problems. When combined with advanced data analysis, they enable a teacher to discover students' performance patterns, predict problems, focus on problematic topics, and find motivational elements (Podgorelec & Kuhar, 2011).

2.3.2 Delivery of distance education

Distance education provides students in higher education the opportunity to take courses utilizing various delivery modes, many of which are technology based (Koenig, 2010). Two such major delivery modes that allow "face-to-face" teaching include videoconference and Access Grid, both of which are used with some groups of mathematics students at UOW, with the rapidly emerging Massive Open Online Courses (MOOCs) offered through online delivery commencing at UOW in 2013 in non-mathematics discipline areas.

2.3.2.1 Videoconference

Videoconferencing is used for a variety of activities such as lectures, tutorials, students, project reviews, remote visits and international meetings organized in the frame of various transnational projects. A videoconference can provide communication in a wide range of situations from live video lecturing to large audiences, to a point-to-point, individual-to-individual desktop PC or multipoint, linking three or more sites with sound and video in real time (Alhlak e, Ramakrisnan, Hameed, Mohseni, 2011; Gorghiu, Gorghiu, Suduc, & Bîzoi, 2011). It allows students and their teacher to be able to see and hear each other instantaneously using monitors (Koenig, 2010). Videoconferencing can also include data sharing such as through the use of an electronic whiteboard on which all participants can draw, or text based real time communication (like e-mail but it appears instantly on recipients' screens), so that all participants can work on the same file (Alhlak et al., 2011). These systems can provide benefits in educational environments where, for example, students who cannot make it to class can participate in a live class meeting from another location; distance students can communicate instantly with their classmates or teachers; experts from around the world can interact with students (Schroeder, 2008). Such systems can reduce costs and save time (Gorghiu et al., 2011). According to a study by Lewis (2010) 50% of students considered that the

videoconference is a successful method of teaching. However, 70% of students indicated that they preferred face-to-face classroom teaching. Possible disadvantages of videoconferencing technology are the difficulty in supporting the interest of the learners, the lack of training and guidance for teachers and/or students (Martin, 2005) and the change in the nature of the student/instructor relationship (Delaney, Johnson, Johnson & Treslan, 2010).

2.3.2.2 Access Grid

There is an Access Grid technology used on desktop PCs or in room-based nodes. This is like videoconference in function, providing video capture, video display, audio capture, audio replay and the sharing of computer images (Aminifar, 2007). Access Grid technology consists of a set of connected computers that can act as the end users or clients, as managers to distribute and control the wanted tasks and as computation machines (Kayser, Görtler, Borkenfeld & Kayser, 2011). There are four types of programs in a Grid (Kayser et al., 2011):

- *data input and output programs (image acquisition and presentation);*
- *application programs (image standardization, evaluation of information);*
- *communication programs (Web communication standards, server access);*
- *network management programs (computer workload, task performance. (p. 2.)*

In Australia including UOW it has been used effectively to provide more subject options to higher level students allowing them to study mathematics and statistics subjects offered at universities throughout Australia. However there are pedagogical issues such as ensuring students at the distant university are not disadvantaged, that they are comfortable with the communication, and that the lecturers are aware of student needs and are trained to use the facilities so they modify their teaching to benefit from the technology rather than repeating traditional lecturing modes (Aminifar, 2007).

2.3.2.3 MOOCS

Higher education institutions in partnership with open education initiatives are creating Massive Open Online Courses (MOOCs). Typically, a MOOC offers online materials broken into manageable chunks, with short video segments, interactive quizzes, communication and other activities (Lewin, 2012). As such, MOOCs rely

heavily on current hardware and software technologies for administration, delivery of learning materials and communication. Organisations such as Udemy, P2PU and Khan Academy have been around since 2008 providing opportunities for anyone to learn with experts, peers and others outside traditional universities and are provided free of charge (Ahn et al., 2013; Yuan &Powell, 2013). Through MOOCs higher education is possible for millions of people with courses in areas such as computer science, mathematics, engineering, public health, and the humanities (refer, Table 2.9).

Table 2.9 Key developments of MOOCS

Initiatives	Scope
edX https://www.edX.org/ • Free to access • Some courses now provide certificates which vary in price by course • No institutional credit	edX offers MOOCs & interactive online classes in subjects including law, history, science, engineering, business, social sciences, computer science, public health, & artificial intelligence (edX, 2013). Between 20 to 30 courses in 2013.
Coursera https://www.coursera.org/ • Free access & certification • For a fee institutional credit for some courses, extra assignments, work with an instructor & assessment (Yuan & Powell, 2013)	Coursera focuses on providing a platform that any university can use. It offers 197 courses in 18 subjects, including computer science, mathematics, business, humanities, social science, medicine, engineering & education.
Udacity https://www.udacity.com/ • Free to access & certification • Institutional credit for some courses	Udacity only offers its own curriculum. Specifically 18 online courses in computer science, mathematics, general sciences, programming & entrepreneurship
Udemy https://www.udemy.com/ allows anyone to teach and • Some free access & some certificates • 1,500 courses not free, $US 20-200 • Offers both for credit & not for credit	Offers over 5,000 courses, in disciplines such as technology, business, design, arts & photography, health & fitness, math & science, education, languages, humanities, social sciences, music, crafts & hobbies & sports.
P2Pu https://p2pu.org/en/ • Free access but no certificates • Institutional credit not offered	Focused on a community centred approach to provide opportunities for anyone who is willing to teach & learn online. There are over 50 courses available & the process of improving the quality of the courses relies on community-review, feedback & revision.

Student motivations to use a MOOC vary with reasons such as: experience or exploring online education, convenience, fun, social experience, intellectual stimulation and finally to support lifelong learning or gain an understanding of the subject matter, with no particular expectations for completion or achievement (Belanger & Thornton, 2013).

There are several pedagogical issues with MOOCs relating to sustainability, knowledge of online pedagogy, the social learning experience and the experience of being dealt with personally, the course quality and the completion rates, and the awarding of higher education credit (Yuan & Powell, 2013). Learners in these courses are expected to be autonomous managing their own learning (Tschofen & Mackness, 2012). MOOCs alone cannot replace degrees or most other formal

qualifications (Clow, 2013). The various providers differ in relation as to whether fees are involved for either for access to the course, access to formal assessment and the granting of qualifications.

2.3.3 Hardware

Three major hardware developments Tablet PCs, iPads and interactive whiteboards have created possibilities in mathematics education. Of these three, two, the Tablet PC and interactive whiteboard were in use in Mathematics at UOW. It appeared given current use of PCs in the Middle East, that introducing the Tablet PC and its benefits would be plausible.

2.3.3.1 Tablet PCs

The characteristics that make a variety of tablets, and in particular Tablet PCs, extremely useful in mathematics education is the ability to alternate between writing on the screen with a stylus and using a keyboard and mouse (Gill, 2007). Writing with a pen on a touch sensitive screen is an important characteristic of the Tablet PC (Fisher, Cornwell, Williams, 2007).

The Tablet PC is able to support the teaching and learning process. When lecturing, the tablet offers three advantages: the ease of writing and erasing which allows the lecture slides to be annotated as the instructor lectures, the ability to save annotations, and the ability to send annotated lectures to students. The Tablet PC also enables a simple but important pedagogical strategy of allowing the lecturer to face students when writing in lectures (Porter & Denney, 2011), a particularly important advance for mathematicians who hitherto have engaged in writing solutions on whiteboards, with their backs to the audience. Screen capture abilities mean that real-time annotated lectures can be captured and streamed over the Internet, and feedback can be provided to students on assignments and resources/videos/podcasts created (Dekkers, Adams & Elliott, 2011). One advantage of digital inking is that it provides an option for handwriting comments on a student's electronic document allowing precise and efficient feedback (Steinweg, Williams & Stapleton, 2010). Further, it is relatively easy to provide a voice over for the annotated documents, allowing students to gain feedback in two modalities, written and aural (Boffey, Gerrans & Kennedy, 2013). These annotated files can be returned to students rapidly via email

after marking. Tablet PC also allow students to get help with long and complicated calculations and they can also use computers and software to simulate and model complex situations described by mathematical structures (Chawla & Mittal, 2013). The potential of the Tablet PC is significant and positive in terms of influencing students' attitudes towards mathematics and their work habits, while also affording them the opportunity to understand the relevance and application of mathematics (Dekkers, Howard, Adams & Martin, 2012). Further, the facilities that allow video capture also enable development of a wide range of learning resources, which can be distributed through eLearning sites and for pedagogical changes such as flipped classrooms, which benefit from such video based resources.

2.3.3.2 Interactive whiteboards

Interactive whiteboards (IWB) are considered to be one of the most revolutionary instructional technologies for various educational levels (Türel & Johnson, 2012). They are of particular interest to mathematicians who often use writing with students to work through mathematics examples. IWBs are "*large, touch-sensitive screens, which control a computer connected to a data projector*" (Gillen, Staarman, Littleton, Mercer & Twiner, 2007, p. 243). Students and/or the teacher can work interactively on IWBs to project Internet access, digital images, video, graphics and audio (Willems & Willems, 2011). IWB functionality is described as follows:

> *Most IWBs have two modes: computer control mode and writing mode. When the IWB is in computer control mode, a pen, or stylus, acts as the mouse, and a tap as a mouse click. In writing mode, the pen, or stylus, acts as an actual writing implement, with the computer producing digital ink on the projected image. Applications of the IWB are dependent on the software that is installed and used on the computer connected to the IWB" (Digregorio & Sobel-Lojeski, 2009, p. 258).*

There are benefits of the IWB for both students and teachers. With a computer connected it is possible to use the whiteboard at distant locations via the Internet and to engage with other classrooms such as occurs with Access Grid teaching. For students, there are several benefits: holding students' attention and providing motivation (Hui-xian, Ming, Yan, & Chun-e, 2009; Türel, 2010; Türel & Johnson1, 2012); positive effects on student achievement (Slay, Siebörger & Hodgkinson-Williams, 2008); enabling better matching of learning to different student learning styles (Schuck & Kearney, 2007, Slay et al., 2008) and, providing an ideal environment for visual learners (Lacina, 2009; Türel, 2010).

Interactions and lectures are recordable and are able to be saved to Acrobat (PDF) documents, PowerPoint slides, or as a movie file (Türel & Johnson, 2012). These are useful learning resources. There are some challenges related to IWB such as technical problems (Gerard & Widener, 2000), which include IWB-computer connections, stylus problems, calibration problems, display problems, and resource availability, including finding materials and appropriate software, making use of other teachers' material (BECTA, 2008; Hutchinson, 2007); and, teachers feeling pressure concerning being well-prepared for class (BECTA, 2008; Cogill, 2002). Teacher training and professional development, particularly in relation to pedagogy is necessary for the effective use of IWBs (Lewin, Somekh & Steadman, 2008; Schuck & Kearney, 2007; Slay et al., 2008). Technical training is also necessary in the effective use of IWBs (Digregorio & Sobel-Lojeski, 2009; Schuck & Kearny, 2007).

2.3.4 Mathematics software

A wide range of mathematical software is available for many computer systems (refer, Table 2.10) and that range of software is used for an even greater variety of tasks than the developers possibly ever considered. The use of technology in the classroom makes higher-level mathematical activities accessible to students. It can also increase awareness among students, helping them to evaluate and correct themselves, and contribute significantly to student engagements, motivation and attitude toward mathematical courses (Kilicman, Hassan & Husain, 2010). A number of commercial symbolic packages for mathematics courses such as Maple, MATLAB, MuPAD and Mathematica can be used as powerful assistants to perform symbol manipulations and computations in algebra as well as calculus (Kilicman et al., 2010). Stemming from its capacity to help visualize concepts and to solve complex problems which are difficult to be solved by hand, packages such as Maple are accompanied by interactive worksheets, animated graphics, and numerous experiments that provide challenges for students and student understanding along with opportunities to explain classical mathematical concepts in a practical and effective way (Kilicman et al., 2010; Khouyibaba, 2010). In addition to these packages, software for mathematics and statistics such as SAS, SPSS, Splus, Eviews, Visual Basic and C++, are seen to help students in internalizing the scientific method and in understanding the mathematical concepts introduced (Saadon, Rambely &

Suradi, 2011). Such technologies are seen as tools to build understanding, cultivate interest, improve the skills and competencies of students in learning, and can also help produce students with critical thinking and creativity in solving a problem (Saadon et al., 2011).

The high cost of standard mathematical packages is often a hardship for students and faculty particularly in developing countries such as those in the Middle East and as a result, more people are joining the open source movement and are seeking ways to circumvent cost, storage and ownership (Herman & Lugo, 2008). Major examples of open source software are shown in Table 2.10.

Table 2.10 Open source mathematics software

Function & Function	Open source alternative software
Maths typesetting: To help lecturers & students to manage tasks related with mathematics.	LaTeX MikTex Mathtype
Symbolic Calculation Software MATLAB, Magma, Maple & Mathematica. To manipulate & compute with symbolic expressions involving factorization or trigonometry (Kusbeyzi et al, 2011).	Sage http://www.sagemath.org/
Numerical Computation MATLAB. For numerical computations with linear & nonlinear problems (Kusbeyzi et al, 2011).	Octave http://www.gnu.org/ GNU Octave http://www.gnu.org/software/octave/ Scilab http://www.scilab.org/ FreeMat http://freemat.sourceforge.net/ jMatlab http://www.jmatlab.org/ Euler http://mathsrv.ku-eichstaett.de/MGF/homes/grothmann/euler/index.html
Computer Algebra Systems Alternatives to Maple & MATLAB For general algebraic & symbolic computations (Kusbeyzi et al, 2011).	Maxima http://maxima.sourceforge.net/ OpenAxiom http://www.open-axiom.org/index.html Yacas http://yacas.sourceforge.net/homepage.html Mathomatic http://mathomatic.orgserve.de/math/
Algebraic Computation for Advanced Linear Algebra Equivalent package Mathematica Compatible with all major operating systems(Kusbeyzi et al, 2011).	Reduce Source: forge.net
Geometry Geometer's Sketchpad is commercial for exploring Euclidean geometry, algebra, calculus, & other areas of mathematics	GeoGebra http://www.geogebra.org/cms/ Fractint http://spanky.triumf.ca/www/fractint/fractint.htmland Xaos http://wmi.math.u-szeged.hu/xaos/doku.php K3DSurf http://k3dsurf.sourceforge.net/
Discrete Mathematics Mathematica, ZED for designing systems using set theory or for Boolean algebra to creating logical solution, programming	GAP http://www.gap-system.org/
Statistical packages: To aid understanding of statistical concepts & procedures such as statistical analysis, data manipulation, & graphing. SPSS 17, JMP 7, S, Ghostgum 4.9, Scilab 5.2.0 & ML Win	S Can be replaced with R

Open source software can be used to replace some proprietary software and this is important for countries such as those in the Middle East where resourcing of software can problematic. For example, in Statistics, the S language, which is used for statistical computing and graphing, provides a wide variety of statistical (for

example, linear and nonlinear modelling, classical statistical tests, time-series analysis) and graphical techniques and is often chosen for statistical methodology research. However R http://www.r-project.org/ can be, and often is used as an alternative. Herman & Lugo (2008) provide lists of open source and free packages, portable applications, media editors and other computing environments at http://people.uncw.edu/hermanr/OpenSourceMath.htm.

2.3.5 Web 2.0 tools

Web 2.0 technologies also play an important role in mathematics education (Khouyibaba, 2010). Schuck , Aubusson & Kearney (2010) describes the term Web 2.0 as,

> *the range of user-controlled publishing and networking websites that have emerged over the past 5 years, allowing people greater connectivity, autonomy, and voice in online activities"(p. 235).*

Web 2.0 technology include media sharing (uploading and downloading media files for purposes of audience or exchange, media manipulation (using web-accessible tools to design and edit digital media files), data/web mashups (combining data from multiple sources to create a new application, tool or service), conversational arenas (one-to-one or one-to-many conversations), online games and virtual worlds, social networking (websites that structure social interaction between members who form subgroups of friends), blogging (an Internet-based journal in which a user can post text and digital material while others can comment), social bookmarking, recommender systems (websites aggregate and tag user preferences for items making novel recommendations), collaborative editing, wikis and syndication (users can 'subscribe' to RSS feed enabled websites so that they are automatically notified of any changes or updates in content via an aggregator) (Crook, 2008).

2.3.5.1 Communication and collaboration

Communication has always been an important component of education, and this is true of education in the Middle East. Web 2.0 technologies facilitate communication, albeit in a different form. Use of social media sites such as Twitter and Wiki spaces in higher education has been extensive (Boyd & Ellison, 2007). The technologies have wide functionally allowing users to converse and interact; to create, edit and share new forms of textual, visual and audio content and to categorize, label and

recommend existing forms of content (Selwyn, 2012). Communication technologies also allow different ways of communicating (http://www.briansolis.com/2009/01/conversation-prism-language-of-human/), passing of documents, music, video and other media between web sites facilitating students to work together and share information.

Apart from the obvious need to communicate what students are to do, communication and collaboration and the interactions that ensue are core to many pedagogical approaches. Social networking software has added a new dimension to online learning, supporting constructivist environments (Ferdig 2007; Kuswara, Cram, & Richards, 2008) that seeks to motivate, cultivate, and meet the needs of the learner (Beldarrain, 2006). It also allows them to collaborate and gain transferable experience through such networks (Holland & Muilenburg, 2011).

One recent collaborative tool, Google docs, opens up new possibilities for collaboration uses the "Cloud". Wang, Von Laszewski, Younge, He, Kunze, Tao & Fu (2010) define Cloud computing as,

> *A computing Cloud is a set of network enabled services, providing scalable, QoS guaranteed, normally personalized, inexpensive computing infrastructures on demand, which could be accessed in a simple and pervasive way"(p. 139.)*

Google Docs, is one such free Cloud application that does not require downloading new software (Oishi, 2007). Users can create 'My Drive' on the Google Cloud as a home for files, which allows multi-users to construct the same file without time and space constraints (Lin & Yang, 2013). Google.doc functions as a web-based word processor allowing users to easily create, edit, and delete writing content in the same document online (Conner, 2008; Lin & Yang, 2013).

2.3.5.2 Resources: Podcasts and videos

Of particular interest to this thesis are open educational resources (OERs) that increase access to education, improve quality, and reduce the cost of education (Kanwar, Kodhandaraman & Umar, 2010). These OER resources are "*digitised materials offered freely and openly for educators, students and self-learners to use and reuse for teaching, learning and research*" (OECD, 2007, p. 10). Educators can access a broad range of learning resources that in many cases are peer reviewed, which they can use and adapt for their own personal learning. They may also be an incorporated into their own units, reducing teaching preparation time, so they can

concentrate their efforts on making students' learning a better experience (Willems & Bossu, 2012).

Many such OER resources have been created through podcasting with media sharing facilities such as YouTube 'Reteachers' and 'TeacherTube' (Conole & Alevizou, 2010) which contain a wealth of scientific and educational videos (Sugimoto & Thelwall, 2013). A podcast can be thought of as "*any digital media file, or series of files, distributed over the Internet for playback on portable media players and personal computers*" (Lonn & Teasley, 2009a, p.88). As such podcasts encompass videos of an earlier era.

In higher education many lecturers have used podcasting as an effective teaching tool, allowing students to download a series of audio or video broadcasts (files) onto a digital media player via a computer. Recorded lectures are seen as helpful for students, with students using lectures for revision and review, because of timetable clashes, and /or work and family commitments, with some students preferring to download rather than attend the lectures (Williams & Fardon, 2007). Other studies suggest that students find podcasts to be efficient, effective, engaging and easily received learning tools for revision (Bongey, Cizadlo & Kalnbach, 2006; Baird & Fisher, 2006; Edirisingha & Salmon, 2007; Evans, 2007). Podcasting appears to enhance the revision process for overseas students, whose first language is not English, with students benefiting from the ability to replay lectures multiple times and, as such, podcasts may also have a significant effect broadening and deepening students' understanding (McGarr, 2009, Panke, 2011). Students believe their learning experience is improved by podcasts (Robson & Greensmith, 2010). Staff can develop a wide range of support resources, often short excerpts, for students learning mathematics to help them identify general mathematical principles and to make connections between concepts.

Different genres of videos can include:

- demonstrations to provide guidance to students on practical work (Carvalho, Aguiar, Santos, Oliveira, Marques& Maciel, 2009);
- worked examples involving the provision of a problem and then step-by-step cues explicitly stating the steps in the development of a solution (Algarni, 2013);

- feedback and instructions in alternative modes (Carvalho et al., 2009; Shim, Shropshire, Park, Harris & Campbell, 2006; Dekkers, 2012);
- theory overviews review material previously learned and needed for a topic (Summertime Math http://www.math.uow.edu.au/subjects/summer/topics/fractions.html);
- orientation videos orientating students to a particular unit of study within a subject or to learning objectives or reducing student worries and angst before entering the classroom (Chan & Lee, 2005);
- stimulus clips to initiate thought or discussion of a particular topic or developing students' study skills through collaborative learning (Carvalho et al., 2009, Porter & Denny, 2011).

A variety of commercial software tools for PCs with varying features and ease of use can be used to create videos and podcasts that allow teachers to make lessons interesting and more effective for students. One of these is Camtasia Studio (http://www.techsmith.com/camtasia.html), which has been used on a PC in the mathematics school at UOW. This is a screen capture program which allows the user to record everything happening on their computer monitor and as such is useful for the creation of a variety of video genre. Key features identified for video development include:

1. The speed of the computer processor. Not all brands of Tablet PCs run at the speed required to smoothly use screen capture facilities.
2. At least one of pdf Annotator, Word, PowerPoint or Beamer is recommended for inking/writing with the stylus.
3. For use with mobile devices and across platforms mp4 files provide maximum access.
4. Small files are important for both storage and for fast web access and for maintaining student attention.
5. Storyboards allow developers to quickly add screen recordings, transitions and title slides to the video sequences.
6. A variety of input formats allow other file formats such mov files, created from a video camera, to be imported.
7. The use of builds and graphics give videos a more professional edge than hand written solutions, although handwriting is popular with students.
8. Strategies can be used to overcome difficulties in removing errors or frames

during post-filming production.

Of potential interest to developing Middle Eastern countries are freely available software tools, with varying features design and construction environments, to create videos and podcasts. Of most interest are those for PCs, such as CamStudio (http://camstudio.org/) and Debut (http://www.nchsoftware.com/capture/), and software available across computer systems such as PowerPoint and Jing (http://www.techsmith.com/jing.html). Freely available tools are also available for the Mac (for example, Copernicus) and the iPad (for example, Educreations and ScreenChomp) although these technologies are less prevalent in developing countries.

While students may use podcast materials for reviewing concepts and issues raised in lectures and the instructors and the students agree that podcasts help students learn, the students are less sure about whether podcasts improve instructors' teaching (Lonn & Teasley, 2009a). It may be that for improved pedagogy "*the true potential of podcasting technology lies in its knowledge creation value and its use as a vehicle for disseminating learner generated content*" (Lee, McLoughlin & Chan, 2008, p. 504). As such podcasts can help instructors change face-to-face instruction from traditional didactic lectures to more constructivist learning practices (Lonn &Teasley, 2009a). Alternatively use of such resources can allow teachers to flip the classroom so that students may review "lecture" clips prior to class and in class undertake activities that relate to the video clips or content.

2.3.5.3 ePortfolios

Often incorporating the use of web 2.0 technologies, ePortfolios are described by Lorenzo and Ittelson (2005) as,

> *a digitized collection of artefacts including demonstrations, resources and accomplishments that represent an individual, group, community, organization or institution. This collection can be comprised of text-based, graphic or multimedia elements archived on a web site or on other electronic media such as a CD-ROM or DVD…..It can also serve as an administrative tool to manage and organize work created with different applications and control who can see or discuss the work (p. 3).*

Three different categories of ePortfolios have been described: students ePortfolios, teacher ePortfolios and institution ePortfolios (Lorenzo et al., 2005). ePortfolios

provide a unique way to document student progress, encourage improvement and motivate involvement in learning (Buzzetto-More, 2006). This is of increasing importance where, for example, pre-service students require a portfolio demonstrating learning outcomes for accreditation or to meet professional standards as well as to reflect on their teaching practices (Ayala, 2006). Teaching ePortfolios can be a collection of course related plans, strategies and artifacts to be shared with colleagues. Student and teaching ePortfolios can be aggregated into an institutional ePortfolio combining a wide variety of digitized materials that provide evidence for institutional accreditation (Lorenzo et al., 2005). One advantage of ePortfolios is they facilitate an exchange of ideas and feedback between those who view and interact with the ePortfolio (Lorenzo et al., 2005). Others focus on the ePortfolio as a learning and reflection process rather than a showcase. For an illustration of showcasing versus learning and collaborating (Barrett, 2009) (refer, Figure 2.1).

Demonstrated benefits include student learning, increased confidence and positive attitudes (Shroff, Deneen & Ng, 2011). One major issue with the use of ePortfolios pertains to retaining access to the portfolios once students have completed their studies (Lorenzo et al., 2005).

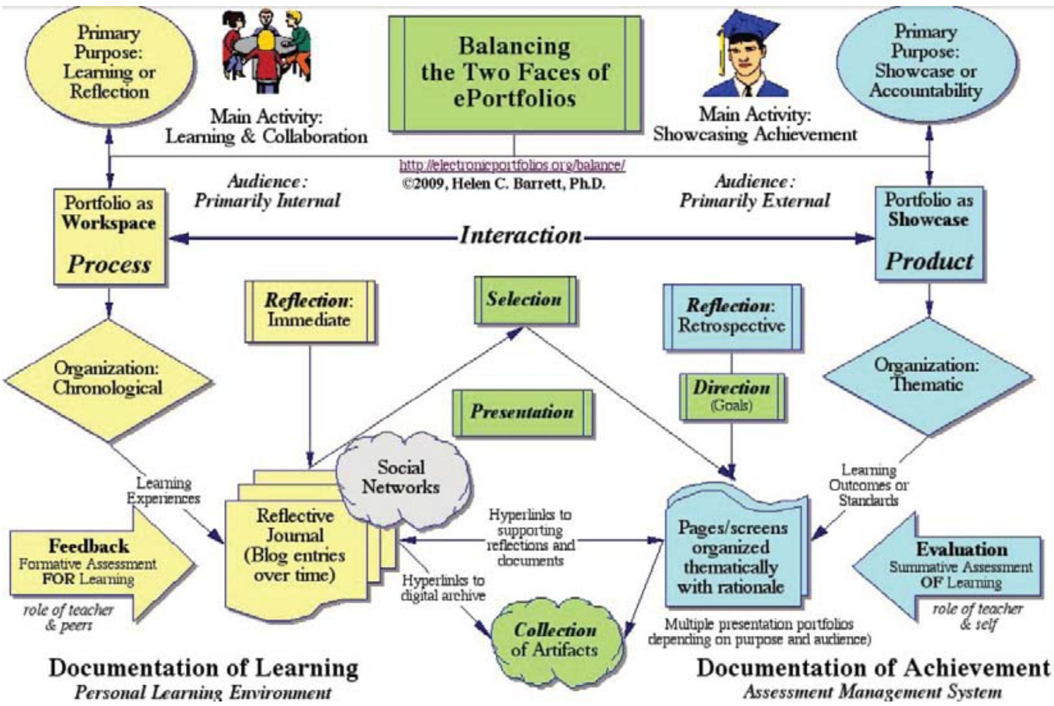


Figure 2.1 Balancing the two faces of ePortfolios
Data Sources: (Barrett, 2010, p. 289)

2.4 Learning design

The adoption of technology on its own cannot improve the learning experience of students. Technology today creates many more possibilities for education than were previously available with face-to-face teaching. With multiple options, blended learning, online learning, videos, podcasts, communications and collaboration there are a multitude of ways for combining resources.

A new learning design methodology has been developed by work started at the UK Open University (http://www.open.ac.uk/blogs/OULDI/) which guides teachers in their design practice (Conole & Wills, 2013). As such learning design becomes of increasing importance. Even in developed countries, teachers are faced with a continuing challenge to review their teaching practices in order to develop and adapt a learning design for teaching with technology (Agostinho, 2006). Mapuva (2009) points out that in developing countries the combination of established traditional pedagogical experiences, based on talk-and–chalk teaching methods, and the shortage of resources have led to difficulties accepting and adapting eLearning. This is particularly problematic in subjects such as mathematics, which benefits from the use of many technologies.

In the educational literature the term "learning design" is used in a variety of ways with Agostinho (2009) identifying six approaches to learning design representations. Agostinho (2009), Oliver (2007) and Conole & Fill (2005) discuss representations of learning designs, which they describe as the outcome of the process of designing and planning a sequence of interactive learning activities. Conole (2013) defines learning design as:

> *A methodology for enabling teachers/designers to make more informed decisions in how they go about designing learning activities and interventions, which is pedagogically informed and makes effective use of appropriate resources and technologies. This includes the design of resources and individual learning activities right up to curriculum-level design.*

The creation of learning designs, representing the process of learning, leads to the possibility of them being shared, adapted and reused by other teachers. This ability to share designs is particularly important for the inexperienced teacher, or when "new ways" of teaching emerge and teachers seek to address questions that have arisen such as to how to run a MOOC or how to flip a classroom. Importantly, building on others' designs can assist lecturers to design high quality learning environments. As

such, learning design is "*a formalism for documenting teaching and learning practice to facilitate sharing and reuse by teachers*" (Agostinho, Bennett, Lockyer, Kostas, Jones & Harper, 2009, p. 11).

According to Oliver (2007) learning design should focus on tasks, supports and resources as these "*provide a strong framework for instructional design, and highlight the importance of planning specific roles for learners, the teacher and the technology in the learning environment*" (p. 343). Learning technology through appropriate design affords students the opportunity to transcend the passive learner role and to take control of their learning (Mishra & Koehler, 2006).

The key components of the learning design, include learning resources, learning activities and learning supports, with assessment as a special learning activity. They can encompass both the students' and instructors' activities and may involve the use of physical resources or the steps of the teaching and learning process. In the eLearning environment, learning designs can be used to provide scaffolding to support student learning. Teachers can provides strategies, resources and links that the students are able to access to complete tasks and to develop their knowledge (Oliver, et al 1996). With this framework it is possible for students to access resources in a multiplicity of ways, choosing which materials to use and how to use them.

Learning Design Visual Sequence (LDVS), as used for example by Baharun (2012), to convey the learning design of a statistics subject uses maps to distinguish resources, tasks and supports in a subject (refer, Figure 2.2).

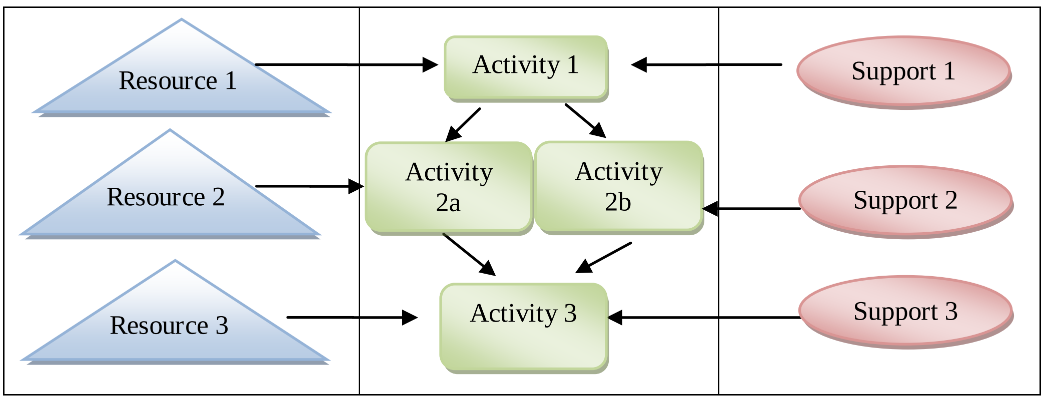


Figure 2.2 Example of concurrent activities in a learning design
Data source Adapted from (Agostinho et al., 2008).

With the elements illustrated as a map, lecturers thinking about design, activities and learning can be prompted and in so doing lead to better learning of experiences for their students. As used by Baharun (2012), it could also be used to communicate to students the intended learning design.

2.4.1 Learning outcomes

Learning is a generic term in the sense that there are a variety of learning outcomes several of which are described by Bloom's Taxonomy. Key features identified for video development include,

1. Remembering: Retrieving, recognizing, and recalling relevant knowledge from long term memory.
2. Understanding: Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.
3. Applying: Carrying out or using a procedure through executing, or implementing.
4. Analysing: Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing, and attributing.
5. Evaluating: Making judgments based on criteria and standards through checking and critiquing.
6. Creating: Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing (Anderson & Krathwohl, 2001, p. 67).

The awareness of these and other outcomes, such as attitudes, engagement and motivation helps make an important shift in an educator's focus: from teaching to learning and the key first step in design, the need to design activities to reach the different outcomes. Teachers can use Bloom's Taxonomy to prepare a classroom plan of how a lesson would be taught and assessed and able to show classroom teachers how the framework could be useful to them as well as to curriculum designers (Krathwohl & Anderson, 2010).

The resources provided, the activities used, and scaffolds or learning support provided become the basis of attaining these learning outcomes and of determining

whether students have active or passive roles (refer, Figure 2.3).

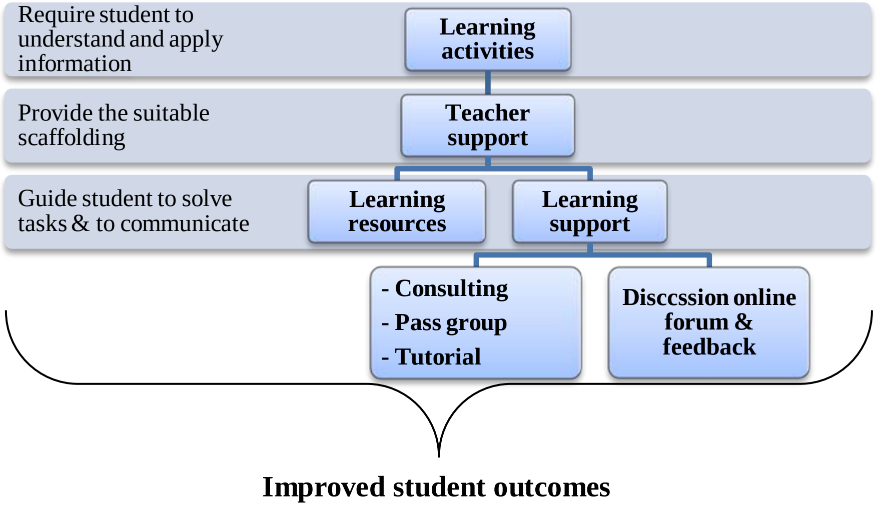


Figure 2.3 Principles of learning design

2.4.2 Design of learning activities

Activities may differ for different learners and in order to achieve different learning outcomes. The activity sequence may include parallel or concurrent activity components for that section of the work. Oliver and Herrington (2003) suggest the three design stages as the basis of effective and efficient approaches to design: the design of learning activities which they considered to include assessment, the provision of learning resources, and the design of learning supports.

The first stage of learning design according to Oliver (1999) involves designing the activities and interactions for engaging and directing the learner in the process of knowledge acquisition, the development of understanding or other outcomes. Instead of being an *"end of course"* activity, assessment is performed in real time as learners demonstrate mastery of important concepts or ideas (Siemens & Long, 2011). Teachers need to be pedagogically aware when designing learning, as the design process involves choices which can lead to the creation of active or passive learning environments., For example, design choices can result in teachers using class time for passive content delivery rather than, say, active learning in the flipped classroom.

2.4.3 Provision of learning resources

The second stage of learning design involves the development and provision of the content, information and resources upon which learning is based given learner interaction. Resources and supports can be specific to one task or may be available

for the entire duration of the learning experience (Agostinho, Harper, Oliver, Hedberg & Wills, 2008). Resources are needed by the learner to successfully complete the set tasks and to facilitate the scaffolding and guidance.

There are many software tools that can help teachers organize resources to be used in teaching such as Prezi (http://prezi.com/). Prezi is a free package which is useful for building presentations and allowing collaboration between teachers on lessons. It can *"create maps of texts, images, videos, PDFs, drawings, and present in a nonlinear way."* (Lightle, 2011). Moreover Google offers a number of EdTech resources for teachers, including email and collaborative apps, videos, lesson plan search, professional development, and even educational grants.

> *Each learner needs resources relevant to his or her profile, learning goals, and the knowledge domain the learner is attempting to master (Siemens & Long, 2011, p. 38).*

2.4.4 Design of learning supports

Support for student learning is an important element in optimizing the student learning experiences in any learning environment (Lee et al, 2011). When preparing a subject, faculty and instructional designers need to address how to support students in various ways, using strategies planned to engage learners with the tasks and to enable them to complete tasks, including scaffolds, encouragements, assistance and connections used to support learning by providing guidance and feedback in the learning process (Lee et al., 2011).

One of the technological advances moving beyond these approaches to learning support are adaptive learning systems such as used in the Khan Academy or Newton (Edudemic, 2013). Adaptive learning environments involve the integration of technologies into an environment or platform to accomplish the goal of enhancing student learning via adaptation. These systems customize learning to create learner-centric learning environments offering flexible solutions that dynamically adapt content to fit individual real-time learning needs (Syamasudha & Siddaiah, 2012). They have mechanisms such as tests to determine a student's competency with content and can direct them to materials or exercises or the next appropriate content area. Such systems may also use technology that adapts to an individual's learning style and modality. Changing the mode of presentation of instruction material enables faster learning by the user as the system tailors its instruction to user learning

styles (Syamasudha & Siddaiah, 2012). The teaching method most associated with the use of educational videos on sites such as the Khan Academy's *"flipped classroom"* in which students learn content by watching videos at home, freeing up class time for hands-on activities, has garnered criticism from some educators (Ash, 2013). Educational video-based websites have been successful with, for example, the Khan Academy which covers a broad number of subject areas, from arithmetic to finance, attracting over 2.5 million unique users (Rogers & Coughlan, 2013). Others suggest the videos are not very good (Ani, 2013), although some note that academics are far more critical evaluating videos than are students who tend to just want more (Porter & Denny, 2011). Videos may form part of support systems for learning (see for example, Summertime Math, http://www.uow.edu.au/~mnelson/teaching.dir/math151.html).

2.4.5 Benefits of learning design

Learning-technology-by-design approaches emphasise learning by doing, and less on overt lecturing and traditional teaching (Mishra & Koehler, 2006). One advantage of learning design is that it allows teachers to move away from a focus on content to better describe and share the teaching process (Dalziel, 2007). The use of learning design can improve the student use of ICT by placing students into an environment where they can better relate to context and practice (Oliver, 1999). Students are more likely to use their knowledge and skills to connect new learning with previous and related learning if they are able to share and discuss ideas in an interactive learning environment. Good learning designs engage learners in building on their expectations and provide students with the confidence to be critical of both themselves and their peers in a supportive environment (Oliver, 2007). Therefore, learning design involves identifying strategies for teachers to encourage students to share their thinking with others and reflect upon their learning. This encourages self-awareness through the knowledge creation process and promotes creativity from students who are involved in the educational process (Oliver, Harper, Hedberg, Wills & Agostinhol, 2002). Although using technology in teaching can be effective, the key points to consider are whether or not this tool adds value to education, how to engage students to use it and what strategies staff should use to create a balance between teaching and learning.

The development of effective online learning environments that meet pedagogical needs requires the application of appropriate instructional design principles (Siragusa, Dixon & Dixon, 2007). In order to improve learning experiences and learning outcomes, lecturers need to understand how learning design can best deliver the learning support students need and how to make effective use of the available resources to improve student learning. Only research and evaluation can confirm how best to use new technologies and to identify technological and other problems that need to be addressed (Lewis et al., 2001). Learning design in the form of lesson plans can be used with technology to best combine resources to enhance face-to-face classroom teaching with blended learning, a mix of face-to-face and online, and online learning.

2.4.6 Issues integrating technology in learning design

There is an increasing and extensive awareness that the pedagogical and technical expertise of the teacher is critical and that ICT can be an effective tool in supporting teaching and learning (Hennessy et al., 2010). Indeed, "*educators [anywhere] find themselves challenged to plan engaging and effective learning experiences for students*" (Agostinho, at el., 2009, p.11).

There are a variety of issues and challenges facing teachers in using learning designs, particularly regarding the use of technology. The effective integration of technology into teaching in ways to support student learning is a challenge that confronts lecturers of mathematics in higher education in many countries (Aminifar, 2007). Each individual teacher has his/her experience, teaching style, and philosophy. It cannot be assumed that all teachers teach the same way and hence do not use technology the same way (Mishra & Koehler, 2006). Rather, technology use in the classroom is context bound and is dependent on subject matter, grade level, student background, and the kinds of computers and software programs available.

In addition to the challenges to providing quality education in the Middle East discussed in Section 2.2 there are challenges to using technology in developing and indeed developed countries. These have been described in terms of:

1. Teacher beliefs and attitudes. Studies highlight the important of teacher beliefs and attitudes (Hew & Brush, 2007; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur & Sendurur, 2012; Hudson, 2012; Cullen, 2001) about the

relevance of using ICTs to promote student learning in the classroom and the impact they have in facilitating successful ICT-integrated teaching practices (Ertmer et al., 2012). The majority of instructors believe technology usage is important for teaching. However, they lack confidence and understanding during integration process (Gülbahar, 2008). Sometimes even a lack of technology interest or computer anxiety by teachers is problematic (Van Dijk, 2005).

2. Availability of software, applications and other resources. These include the lack of available hardware, software, applications, networks, and the usability of ICT devices and applications (Van Dijk, 2005; Zbiek & Hollebrands, 2008; Fuchs & Horak, 2008), and the lack of development funds (Chaudary & Imran, 2012; Nicholls, 2001; Cullen, 2001). Teachers often lack mathematics curriculum materials or resources that capitalize on technology (Zbiek & Hollebrands, 2008; Hew & Brush, 2007).
3. Support. Teachers need to be supported with access to professional development with strong technical support, peer support and system support (Attard, 2011). Teachers also need support from university leadership (Al-Senaidi et al., 2009; Hew & Brush, 2007), removing barriers to integrating technology such as structures at the universities, lack of academic freedom and tenure and promotion procedures (Polly, Grant, Gikas, 2011). They often lack technical expertise resulting in an inability to trouble shoot problems with computers (Hudson, 2012) and lack technology support (Hudson, 2012; Hoyles, Lagrange, Drijvers, Kieran, Mariotti, Ainley, Meagher, 2010; Zbiek & Hollebrands 2008).
4. Lack of time. Many studies discuss the lack of time: the lack of time in terms of time to integrate technology into already tightly scheduled class periods (Zbiek & Hollebrands, 2008); to undergo training (Hudson, 2012; Al-Senaidi et al., 2009; Hoyles, et al., 2010); with teachers focusing on research for promotion rather than integrating technology into teaching purposes (Polly et al., 2011). There may be a lack of time to design and plan technology rich activities (Al-Senaidi et al., 2009) and the time it takes for students to learn to use the equipment and software programs takes away from time learning mathematics Hoyles, et al. (2010). When teachers feel confident and have spent time considering, planning, and preparing for teaching, they are able to

identify appropriate tasks where ICT provides support or opportunities for science learning (Otrel-Cass, Khoo & Cowie, 2012).

5. The rapid rate of technology change. Technology is changing so fast that any method that attempts to keep teachers up to date with the latest software, hardware, and terminology is doomed to create knowledge that is out of date every couple of years (Mishra & Koehler, 2006).
6. Pedagogical awareness. Lecturers need to be able to identify how to provide an environment that can accommodate individual students' needs, promote deeper approaches to learning and engage students as active participants in learning experiences with use of ICT. A lack of knowledge of teaching strategies using computers is another challenge when integrating technology into teaching (Hudson, 2012; Hew & Brush, 2007). An emphasis on learning the technology may lead to an emphasis on students learning technology (technology as the subject and content of learning) rather than the subject matter that they are supposed to learn (Mishra & Koehler, 2006). Teachers may also lack knowledge of classroom management strategies for using computers (Hudson, 2012). Specifically a lack of lesson plans using computers (Hudson, 2012) and techniques for managing pressures associated with frequent high-stakes assessments that leave little time for computer work (Hew & Brush, 2007; Polly at el., 2011).

2.5 Professional development

Knapp (2003) describes professional development or staff development as "*professional learning: that is, changes in the thinking, knowledge, skills, and approaches to instruction that form practicing teachers' or administrators' repertoire*" (p. 112). Professional development is a dynamic process that spans one's entire career, from preparation and induction to completion (Nicholls, 2001)

The teaching activities of many academics focus on the transmission of knowledge through their lecturing role. Consequently the movement to online teaching often begins by conceptualising the electronic environment as a content repository for disseminating unit information, lecture notes and PowerPoint files. This approach does not optimise the capacities of the new environment and is far removed from the concept of student-centred learning. Learning technologies offer much greater

possibilities than being mere content repositories, through the creative use of a wide variety of appropriate Internet-based and other communications tools. Ramsden (2003) comments that "*if we really want to improve the quality of higher education, the principles of effective teaching must also be applied to the task of … educating lecturers*" (p. 13).

To transition from a traditional mathematics teaching approach to a technology based approach, teachers need to learn how and when to use the technology (Pierce & Ball, 2009). It is not enough to embed ICT into curriculum documents. Hudson (2012) concluded that they were more likely to use a mathematics package or computers in the classroom if teachers had training on the mathematics package. Three factors that appear to have a significant influence on the effective use of technology: the quantity and quality of the lessons addressing technology in the curriculum, incompetent teachers/lack of in-service training, and insufficient technological infrastructure (Gülbahar, 2008). The transition towards becoming a new online teacher may result in some difficult experiences with regard to locating digital resources and useful learning activities (Rieber, Francom, Jensen, 2011). Rieber et al. (2011) suggest that becoming an effective teacher with technology requires extensive professional development and the best people to provide that guidance are those who have skill resulting from experience. However, Polly et al. (2011) highlighted the need for a centralized service, with professional development driven by an institution-wide unit specific for teaching or faculty development. Along with this there is a need to develop different ways to train and educate all those who are involved in decisions about and realization of education in mathematics with technology (Chawla & Mittal, 2013).

What constitutes the necessary in-servicing or professional development of teachers may include a combination of things:

- Focus on learning how and when to use the technology. To transition from traditional mathematics teaching approaches to technology-based approaches, teachers need to learn how and when to use the technology (Pierce & Ball, 2009).
- Focus on situating learning activities in authentic contexts (Wilson & Stacey, 2004).

- Knowledge and skills to reflect and to offer opportunities for staff to share experiences, ideas and reflections as they engage as learners (Wilson & Stacey, 2004) and to reflect on processes and change accordingly (Nicholls, 2001).
- Support. Teachers need support if they are to identify how and when ICTs can contribute to problem solving, finding answers or communicating ideas as part of students learning activity (Otrel-Cass et al., 2012). Support requires: a suitable combination of learning environments; appropriate time and space; and, availability of both learning resources and people able to offer support (Eraut, 1994).
- Ongoing development should be a key feature of all professionals' work (King, 2004).

For technology to become an integral component of learning, science and mathematics pre-service teachers must also develop an overarching conception of their subject matter with respect to technology and what it means to teach with technology (Niess, 2005). With respect to professional development, Polly et al., (2011) expressed the view that in order to integrate technology into their classroom effectively, teachers have to be knowledgeable about the relationships between technology and content, technology and pedagogy, and content and pedagogy. The *Technology, Pedagogy and Content Knowledge* (TPCK) framework allows teachers to identify what is important in any discussions of teacher knowledge surrounding the use of technology for teaching subject matter (Mishra & Koehler, 2006). Koehler & Mishra (2008) illustrate the model (refer, Figure 2.4), and areas of intersection of technology (TK), such as books and chalk, Internet and digital video, "*and the different modalities they provide for representing information*", pedagogy (PK), "*process and practice or methods of teaching and learning, including the purpose(s), values, techniques or methods used to teach, and strategies for evaluating student learning" and content (CK),* "*the subject matter that is to be learned / taught*" (Koehler, Mishra & Yahya, 2007, p. 743).

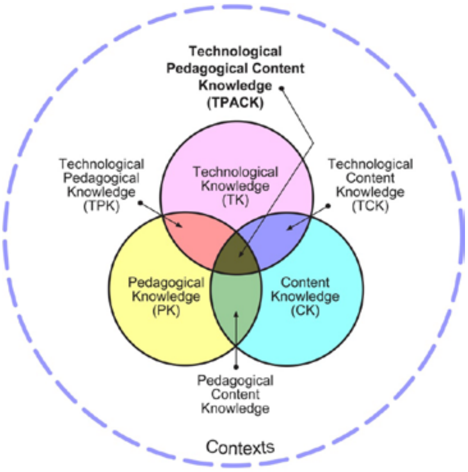


Figure 2.4 Framework of technological pedagogical and content knowledge
* Source: (TPACK: Koehler & Mishra, 2008)

The fundamental challenge for teaching staff is to learn how to use new tools and apply them in pedagogically effective ways (Benson, 2012). In addition to academic staff developing new skills, it is necessary for them to make fundamental adjustments to pedagogical and philosophical assumptions. Models such as TPACK may assist in this.

2.5.1 Model for professional development

Academic staff learn in a diversity of ways such as in discussions with their colleagues (Baume 1999; Viskovic, 2006), reflection by considering their own experiences (Lawler & King 2003) and in-service training. Indeed, academic staff are willing to participate in and have positive attitudes toward participating in any course, seminar, and workshop about technology usage, which reveals the need for professional development Gülbahar (2008). Ferman (2002) and Baume (1999) recognized a variety of collaborative and individual activities for professional development in higher education. These activities involve working with an educational designer, attending workshops, discussions with peers, presenting at conferences, being mentored and undertaking professional reading. Development can also take place through committees, working groups, professional work, job shadowing and exchange (Baume, 1999), professional interactions, networking, consulting experts, personal research, learning by doing, and learning by teaching Becher (1996). Hudson (2012) drew attention to three different foci for professional development: 1) tools for mathematics teaching 2) the needs in technology training and need to know about technology tools, and 3) change in classroom practices (use

and non-use of technology).

There are several approaches to professional development ranging from a focus on showing staff how to operate equipment and software to showing how to integrate technologies into instruction. The focus, in terms of outcomes, of such programs can also vary. Littlejohn (2002) suggests that where professional development is offered it needs to encourage academics to concentrate on the educational design process, that is, on course outcomes rather than content, placing dialogue and feedback central to course design, and incorporating current educational theory. This may be achieved through project-based support, in which academics focus their efforts on how students learn. Three approaches to professional development have been canvassed: community of practice, the Ellis model and follow up support.

2.5.1.1 Community of Practice

Community of practice is defined by Eckert and McConnell-Ginet (1992) as,

> *A community of practice is an aggregate of people who come together around mutual engagement in an endeavor. Ways of doing things, ways of talking, beliefs, values, power relations-in short, practices-emerge in the course of this mutual endeavor. As a social construct, a community of practice is different from the traditional community, primarily because it is defined simultaneously by its membership and by the practice in which that membership engages (p. 466).*

Lesser and Prusak (2000) argue that communities of practice are "*the major building blocks in creating, sharing, and applying organizational knowledge which is a necessary condition for knowledge creation, sharing, and use*" (p. 124). A community's purpose and goals is to inform the appropriate activities and technologies that should support it. Many virtual communities of practice depend on face-to-face meetings and Web-based collaborative environments to communicate, connect, and conduct community activities (Cambridge, Kaplan & Suter, 2005). It encourages formal change in professional practice (Wenger, 1998).

2.5.1.2 Ellis Model

Many models describe a four-stage approach to professional development, with respect to online learning. This approach distinguishes the need for a different level of support for individual staff members who are interested in developing expertise in online teaching or who are independently updating their knowledge and skills (Ellis,

in press). The first stage involves activities that aim to increase the interest and motivation of individual staff members as to the possibility of being involved in online course development. This includes assistance in mastering appropriate hardware and software, provision of access to resource sites in their discipline or interest area and provision of short seminars on current online activities within the institution, and lessening the learning from visiting experts. The second stage involves supporting the staff members’ development by training in instructional design, addressing issues of online pedagogy and technical training with appropriate software products and course management. In the delivery of newly developed materials some implementation issues arise and revision is useful, allowing support staff to review and modify the developed material on the basis of experience and feedback provided. The third stage involves further development and extension of staff members’ skills by challenging them to extend their work into more complex areas. The final stage involves acknowledgment of the staff member's new skills and expertise and encouraging them in turn to mentor and train other staff members at Stage 1. These four stages characterised the staff development implemented in Case Study 3.

2.5.1.3 Follow up support

Polly et al. (2011) identified three elements for current professional development: activities which include tool-based workshops, follow-up support, and, faculty interest (refer, Figure 2.5). The tool-base workshops include how to integrate different tools into teaching. The follow-up support involves in time support, or structures including individual faculty support, support within colleges and department-level support, faculty interest and belief in the professional development

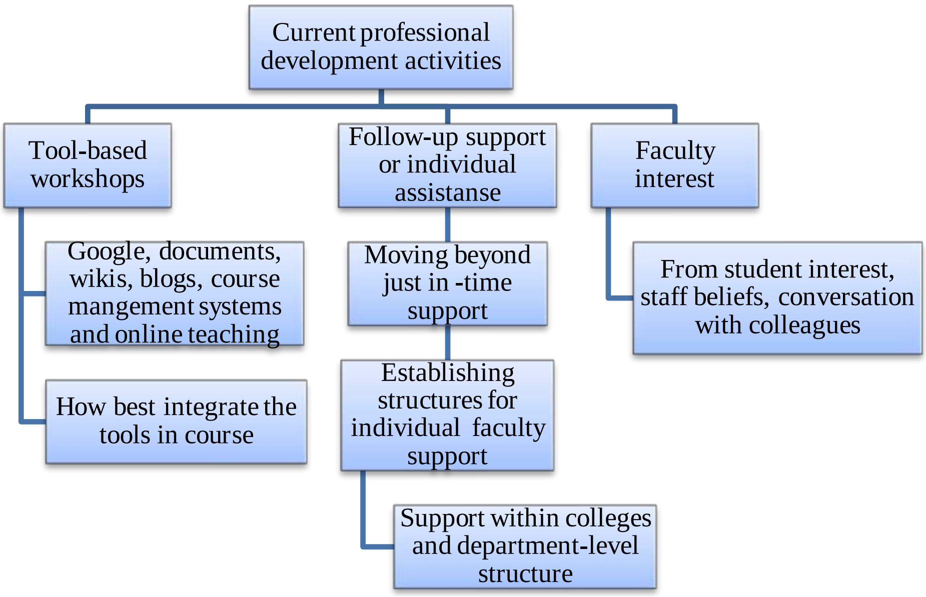


Figure 2.5 Professional development activities

2.6 Closing the technology gap

There is a gap between the state of ICTs and the levels of access and utilisation of the Internet in developed nations and the situation in less developed countries (Cullen, 2001; Fuchs & Horak, 2008; Van Dijk, 2005). There are many limits to the use of ICT in education in developing countries in terms of hardware, software and expertise. However, the main issue to better utilization of ICT is not so much the lack of access to information technology, but the lack of proper knowledge, education and skilled owner-managers and employees within enterprises (Arendt, 2008; Apul & Latham, 2009). Training of academics in developing countries to integrate technology is required to increase their awareness of the educational possibilities afforded by technology and of what can be achieved as there is both a lack of the awareness of the various technologies and of the benefits of adopting ICT in the learning process (Apulu & Latham, 2009).

The solution to bridging the gap between developed countries and developing countries requires:

1. Understanding of local needs and conditions (Apul & Latham, 2009).
2. Government incentives and financial support to introduce training programs on how to use technology and the benefits of adoption of technology in the education (Apul & Latham, 2009).
3. Proper understanding by policy makers of ICT adaption and how to enhance

learning (Apul & Latham, 2009).

4. Education and access to ICT (Fathurrohman, 2013).
5. eLearning as a possible solution to bridge the education gap (Ali et al., 2011).
6. An integrated strategy combining: educational digital literacy programs; public and free access to computers and technologies; open source technologies; and computers (Fuchs, Horak, 2008).
7. Technology options to achieve access to ICTs in developing countries include: terrestrial wireless, satellite technologies, wire or line technologies, and technologies such as digital compression, VOIP, community radio (Rao, 2005), connectivity provision, content creation, capacity augmentation, core technologies-creation, cost reduction, competence building, community participation and commitment to the deprived and disadvantaged (Rao, 2005).
8. All instructional technology research focuses on questions of how people learn and perform, especially with respect to how learning and performance are influenced, supported, or perhaps even caused by technology (Reeves et al., 2005).

To keep the ICT adoption and adaptation process continuing in developing countries requires that: the implementation of ICT is monitored; ICT is used to achieve socio-economic development; a model for ICT in education with appropriate providing affordable ICT infrastructure for education; professional teacher development with regard to ICT; collaboration in the development of digital learning materials in terms of the quality of the content, relevance to the lives of learners and cost savings that would result from shared development; and, leadership provided so effective implementation of ICT in education in one region can foster other regions (Farrell et al., 2007, p. 31).

In the next chapter the methodologies for undertaking the case studies, *Redesign of eLearning*, *Technologies used in Higher Mathematics Education* and *Professional Development for the Middle East* are discussed.

3 Methodology

This chapter explores possible methodological approaches for the conduct of this research. Adopting a mixed methodology framework involving three case studies, the first case study examines best practices in using technology to create blended learning. Such practices include the use of learning managements systems, tablet technology, video resources and learning designs. In the second case study conducted in parallel with the first, the why and how of technology use in mathematics education and the needs for professional development with respect to technology is examined. The third and final case study involves the implementation and evaluation of a professional development programme. The three case studies address the main research question "How can tertiary mathematics education in the Middle East countries, specifically in Libya and the Sultanate of Oman, be enhanced through the integration of technology?"

3.1 Introduction to research methodology

Educational research is the way in which one acquires dependable and useful information about the educative process. Its goal is to discover general principles or to provide interpretations of behaviour that can be used to explain, predict and control events in educational situations and to formulate scientific theory (Ary, Jacobs & Razavieh, 1996).

> *Research is an examination process that has different components, which include reflective inquiry (problem statement, literature review and theoretical framework, logical structure, objectives, and, as appropriate, research questions and hypotheses); the procedures, or research design and method(s) of data collection; the gathering, processing, and analyzing data; the issues of reliability and validity (quantitative study) or credibility, trustworthiness, transferability, dependability, and confirmability (qualitative study) and finally the extension of the third component: presentation of research findings (Hernon, 2001, p. 81).*

Methodology is concerned with description and analysis of research methods rather than with the actual practical use of those methods (Opie, 2004). A methodology defines how one will go about studying any phenomenon (Silverman, 2009). That is, a method is a practical application of doing research whereas a methodology is the theoretical and ideological foundation of a method (Wahyuni, 2012). The scientific research methodology used in education research includes quantitative research, qualitative research and a combination of the two, known as mixed methods (Fraenkel & Wallen, 2006).

3.1.1 The problem and context

This research was conducted in order to develop, trial and evaluate an effective template, or structure, for embedding mathematics learning support into eLearning systems in Middle Eastern countries. To highlight the contrasts between Western and Arabic culture, the research approach involved the immersion of the researcher, from Libya, into the Australian teaching and learning culture. This involved working on subject development with academic staff, investigating the development of video resources such as worked examples and orientation clips and the associated use of learning designs to develop student eLearning sites. Immersion also involved interviewing Australian staff and students so as to identify which technologies they use and how they use them in teaching or learning mathematics and research. It was the aim of this research to identify and find ways to emulate best practices in teaching mathematics in a developed country and to make available equivalent technologies for staff in a developing country. From this strategies were to be devised for the prioritised introduction of equivalent technologies in developing Middle Eastern countries.

3.1.2 Research questions

The overarching research question "How can tertiary mathematics education in the Middle East countries, specifically in Libya and the Sultanate of Oman (Oman), be enhanced through the integration of technology?" involved asking many more specific questions as summarised in Table 3.1.

Table 3.1 Research questions

Case study 1 Redesign of eLearning	• How effective is the current subject in terms of impact on students' confidence or perceived competency? • How effective are the offline resources and the online learning provided in terms of usefulness in helping students understand? • How effective is the design of the eLearning site in terms of its provisions of attributes such as clarity or good access to materials?
Case study 2 Professional development for technology in mathematics education	• What technologies are being used in tertiary mathematics education? • How and why they are used? • What is the need for the professional development? • What are the strategies for professional development?
Case study3 Professional development in the Middle East	• What is the current access to technology in mathematics departments in the Middle East? • What technologies and functionalities can be introduced to Middle Eastern countries for mathematics education from a technical/ cost perspective? • How can professional development be used to introduce the technology to Libyan and Omani mathematics staff?

3.1.3 Paradigms

In a research context, the term ‘paradigm’ describes a system of ideas, or worldview, used by a community of researchers to generate knowledge (Fossey, Harvey, McDermott & Davidson, 2002). The selection of a paradigm provides an interpretive framework. Johnson, Onwuegbuzie & Turner (2007) define a research paradigm to be

> *a set of beliefs, values, and assumptions that a community of researchers has in common regarding the nature and conduct of research. The beliefs include, but are not limited to, ontological beliefs, epistemological beliefs, axiological beliefs, aesthetic beliefs, and methodological beliefs (pp. 129-130).*

The main philosophical dimensions of existing research paradigms are ontology, epistemology, axiology and methodology (Mertens, 2005 & Kalof et al., 2008). Ontology is the view of how one perceives a reality (Mertens, 2005& Wahyuni, 2012). Ontology addresses the following question: “What is the form and nature of reality and what can be known about that reality?”. Epistemology is concerned with the relationship between the “knower” (the research participant) and the “would-be knower” (the researcher) (Ponterotto, 2005). Epistemology is the philosophy of knowledge or how we come to know (Trochim, 2000). The epistemological question asks, “*What is the nature of knowledge and the relationship between the knower and the would-be known?”* Mertens (2005, p. 8). Axiology concerns the role of researcher values in the scientific process (Ponterotto, 2005). The methodological question asks, “*How can the knower go about obtaining the desired knowledge and understandings?”* Mertens (2005, p. 8).

Freshwater and Cahill (2013) present the notion of a paradigmatic frame to show how paradigms can be understood as a continuum of increasing generalization as follows:

- ***Paradigms as worldviews****. Fragmentation: what methods cohere with one’s worldview, including epistemology, ontology, and axiology and solve specific problems informed by accepted practice?*
- ***Paradigms as epistemological stances****. Specialism: what methods cohere epistemologically, ontologically, and axiologically and solve specific problems informed by accepted practice?*
- ***Paradigms as shared beliefs****. Utilitarianism: what methods cohere axiologically and solve specific problems informed by accepted practice?*
- ***Pragmatism****: what methods cohere in the service of solving specific problems informed by accepted practice?*

- ***Paradigms as model examples**. Eclecticism: what methods cohere, informed by accepted practice? (p. 5).*

Three research paradigms are positivism, interpretivism and pragmaticism:

- Positivism. In the positivist paradigm, the object of study is believed to be independent of the researchers: knowledge is discovered and verified through direct observations or measurements of phenomena. Facts are established by taking apart a phenomenon to examine its component parts (Krauss, 2005). There is a real world of objects apart from people. This allows for prediction, control, and empirical verification (Cohen & Crabtree, 2008).
- Interpretivism. In the interpretivist paradigm researchers favour interacting and having a dialogue with the studied participants in order to understand the social world from the experiences and subjective meanings that people attach to it (Wahyuni, 2012). Individuals are recognised as having their own varied backgrounds, assumptions, and experiences which contribute to the on-going construction of reality existing in their broader social context through social interaction. Experiences and values of both research participants and researchers substantially influence the collection of data and its analysis (Wahyuni, 2012). The values of researchers are considered to be inherent in all phases of research, with truth negotiated through dialogue and findings or knowledge claims created as an investigation proceeds, and emerge through dialogue and negotiations of meanings among community members (Cohen & Crabtree, 2008).
- Pragmatism. Pragmatists start with the research question and then determine their research framework. They emphasise that one should view research philosophy as a continuum. "*A mixture of ontology, epistemology and axiology is acceptable to approach and understand social phenomena. Pragmatist researchers favour working with both quantitative and qualitative data because it enables them to better understand social reality*" (Wahyuni, 2012, p. 71).

In this study the researcher selected *pragmatism* to focus on the interpretation of experience with use of different technologies, and associated with this both qualitative and quantitative action research combined in a manner that can best be described as mixed methodology. The terms quantitative and qualitative apply to methods of data collection and choice of methods rather than the epistemologies,

designs, and ontological assumptions that are associated with different research frameworks (Biesta, 2010).

3.1.3.1 Qualitative research

Qualitative research seeks to make sense of social phenomena as they occur in natural settings (Kervin, Vialle, Herrington & Okely, 2006). Central to good qualitative research is whether the research participants' subjective meanings, actions and social contexts, as understood by them, are illuminated (Fossey et al., 2002). Qualitative researchers believe that researcher participation enriches the study and participants are purposely sought who have experience of the phenomenon under investigation and who can answer the research question (Erlingsson & Brysiewicz, 2012). Such research addresses 'how' questions rather than 'how many', and is used for understanding the world from the perspective of those studied and for examining and articulating processes (Pratt, 2009). A qualitative method adds contextual and cultural dimensions, which deepens a study by providing more natural information (Luo & Dappen, 2005). Qualitative studies are considered to be interpretive and descriptive in which the subjects and settings are not usually manipulated by the researcher (Savenye & Robinson, 2005). Researchers conducting qualitative studies embrace the ontological assumption of multiple truths or multiple realities meaning that each person has an understanding of reality from an individual perspective (Erlingsson & Brysiewicz, 2012).

Data collection can be undertaken by several common qualitative methodologies, including case study, grounded theory, observations, interviews, and document and artifact analysis (Savenye & Robinson, 2005). Qualitative research comprises,

> *deep, rich description and is more concerned with process than specifying outcomes or products.... data are analysed in an inductive process to provide meaning to the research consumer" (Campbell 1997, p122).*

The most important features of qualitative research are induction, finding, investigation, theory/ hypothesis generation, the researcher as the primary instrument of data collection, and qualitative analysis (Johnson & Onwuegbuzie, 2004).

Two research paradigms that inform qualitative research methodologies, namely the interpretive and critical research paradigms, place an emphasis on seeking understanding of the meanings of human actions and experiences and on generating

accounts of their meaning from the viewpoints of those involved (Fossey et al., 2002). A key descriptor of the methodology in this study is phenomenology, a research inquiry approach coming from philosophy and psychology in which the researcher describes the lived experiences of individuals about a phenomenon as described by participants (Creswell, 2008). Thick description is used to direct behaviors in which people are engaged and its context understandings of those behaviors that render the event or action meaningful. From this perspective the qualitative researcher is part of the study and is, in fact, the research instrument (Erlingsson & Brysiewicz, 2012).

3.1.3.2 Quantitative methods

Quantitative research seeks to determine the relationship between variables, mainly in the form of a cause and effect relationships (Kervin at el., 2006). The quantitative researcher strives to minimize variation in the studied phenomenon and believes it is possible not to influence or bias results. Many argue that quantitative methods offers fairly standardized, efficient, amenable information, which is easy to summarize and to analyse (Luo & Dappen, 2005). Researchers conducting quantitative studies seek the truth and see reality as something ‘‘out there’’, outside themselves (Erlingsson & Brysiewicz, 2012). Qualitative researchers often have their work evaluated in terms of a “scientific” frame that sees numbers as a key indicator of valid and generalizable research. Stories of quantitatively oriented journal reviewers insisting that numerical results be added to qualitative papers are common (Maxwell, 2010). While quantitative research techniques are suitable for the testing of theories and hypotheses Muijs (2004) argues that quantitative methods fail to explore problems in depth providing information in breadth from a large number of units. To get “under the skin” of phenomenon other methods such as in depth interviews, case studies or other qualitative techniques are required.

3.1.3.3 Comparing qualitative and quantitative methods

Leedy & Ormrod (2010) differentiate between qualitative and quantitative approaches in terms of the purpose of the study, the nature of the research process, the data collocation, how the data is analysed and the findings (refer, Table 3.2).

Table 3.2 Distinguishing of qualitative and quantitative approaches
(Source: Leedy & Ormrod, 2010, p.96)

Questions	Quantative research	Qualitative research
What is the purpose of the study	To explain and predict To confirm and validate To test theory	To describe and explain To explore and interpret To build theory
What is the nature of the research process	Focused Known variable Established guidelines Predetermined methods Somewhat context-free Detached view	Holistic Unknown variable Flexible guidelines Emergent methods Context-bound Personal view
What are the data like and how they are collected	Numeric data Representative, large sample Standardised instruments	Textual and or image-based data Informative, small sample Loosely structured or non-Standardised observations and interviews
How are data analysed to determine their meaning	Statistical analysis Stress on objectivity Deductive reasoning	Search for themes and categorise Acknowledgment that analysis is subjective and potentially biased Inductive reasoning
How are the findings communicated	Numbers Statistics, aggregated data Formal voice, scientific style	Words, Narratives, individual quotes Personal voice, literary style (in some disciplines)

Even though there are many important differences between qualitative and quantitative research, there are some similarities between the approaches such as the use of empirical observations to address research questions (Johnson & Onwuegbuzie, 2004). However, there is much debate regarding the worth of the qualitative and qualitative approaches,

> *Although most of the debate between qualitative and quantitative researchers during the "paradigm wars" centered on differences in methods and "paradigms" rather than data, some of the methodological differences, such as "observations" versus "measurement," imply a distinction between numerical and nonnumerical data; this distinction is also conveyed by the terms hard and rich data and is implicit in the charge of "imprecision" that has been leveled against qualitative methods (Maxwell, 2010,p 476).*

Quantitative and qualitative strategies ask different questions. A quantitative study might ask how people intend to vote, and the method of data collection required is surveys or questionnaires, while a qualitative study might attempt to understand what people mean by what they do in their everyday behaviour, here the method differs; interviews and focus groups are appropriate (Bapir, 2012).

3.1.3.4 Mixed methods

Mixed methods research is used to enable understanding and answering a broader and more complete range of research questions because the researcher is not confined to a single method or approach (Johnson & Onwuegbuzie, 2004). Mixed

methods research has been defined as follows,

> *Mixed methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g. use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration" (Johnson et al. 2007, p. 123).*

Others place focus on the manner in which the qualitative and quantitative components are combined, sequentially or concurrently with an emphasis placed on the integrated use of data. In a mixed methods study,

> *the researcher collects and analyses persuasively and rigorously both qualitative and quantitative data…; mixes (or integrates or links) the two forms of data concurrently by combining them (or merging them), sequentially by having one build on the other, or embedding one within the other; gives priority to one or both forms of data (in terms of what the research emphasizes); uses these procedures in a single study or in multiple of phases of a program of study; frames these procedures within philosophical worldview and theoretical lenses; and combines procedures into specific research designs that direct the plan for conducting the study (Creswell & Clark, 2011 p. 5).*

Hence mixed methods research can be used to enhance the interpretation of significant findings in educational evaluation research studies (Onwuegbuzie & Leech, 2004). With this study, recognising that there can be varying perspectives, suiting pragmatism as a paradigm, mixed methodologies offers a means of gathering different perspectives. With all data collection there is a need to address issues of reliability and validity.

3.1.4 Reliability and validity

In quantitative research researchers were long thought to be objective, separate and detached from the experiment and subject under investigation. Three types of reliability were referred to in quantitative research: the degree of consistency of results, the stability over time and the similarity within a given time period (Kirk & Miller, 1986). According to the quantitative research paradigm, methods are considered reliable if they are sufficiently free of bias to consistently produce the same results given similar contexts, which means similar participants and similar research conditions (Collingridge & Gantt, 2008). However, reliability is not sufficient; methods also need to produce valid data. In broad terms, validity determines whether the research truly measures that which it was intended to measure or how truthful the research results are. Different kinds of validity are

described in the literature including:

- Construct validity reflects a concern with whether an underlying construct such as emotional well-being, physical comfort, and pain is truly being assessed (Collingridge & Gantt, 2008; Sanchez-Cubillo, Perianez, Adrover-Roig, Rodriguez-Sanchez, Rios-Lago, Tirapu & Barcelo, 2009).
- Content validity reflects a concern with whether the measurement tools provide an adequate measure of the construct of interest (Collingridge & Gantt, 2008).
- Criterion validity refers to the strength of the relationship between the measurement tools and other measures of the same phenomenon (Collingridge & Gantt, 2008).
- Convergent and discriminant validity, a type of construct validity is used to measure how well the items measure the constructs of interest (Lee, Segal, Kimberlin, Smith & Weiler, 2013).
- Face validity is not about what the model actually measures but about what it superficially appears to measure (López de Castro, Gracia, Peiró, Pietrantoni & Hernández, 2013).
- *‘‘Predictive validity deals with how well a measurement instrument forecasts or predicts an outcome’’* (Frey, Botan & Kreps, 2000, p. 117).

Validity and reliability are extremely important to the quantitative researcher, although there is a shift to the notion of "trustworthiness" for qualitative research. For the qualitative researcher,

> *The trustworthiness of the study is supported by providing examples of raw data, (often interview quotes) and an analysis process that exemplifies the results. Trustworthiness is also supported by meticulously describing the methodological steps. Sometimes participants themselves are called upon to judge the trustworthiness of the study, e.g., the researcher returns to the participants and requests them, as ‘‘experts’’, to confirm the authenticity of the conclusions (Erlingsson & Brysiewicz, 2012, p. 97).*

The trustworthiness of study relates to four criteria: credibility (internal validity); transferability (external validity); dependability (in reliability) and confirmability (objectivity) (Lincoln & Guba, 1985).

In order to validate the data, or in this study to ensure data and interpretations were trustworthy (Creswell & Miller, 2000) data, investigator, methodological and environmental triangulation, were implemented (Guion et al., 2002). Therefore, in this thesis, validating outcomes was obtained through triangulation (refer Table 3.3 and Section 3.1.5). This triangulation gave rise to both a large quantity of data as well as a diverse data set. This data together with thick description both of the data as well as the educational environment in which participants worked and studied was to promote trust in the interpretations of findings. Validity is gained by “researchers look[ing] for convergence among multiple and different sources of information to form themes or categories in a study” (Creswell & Miller, 2000).

Table 3.3 Validation of research tools

Instruments	Trustworthiness
The Change Evaluation Survey	• This was found to be predictive of change (Porter, 2007, Baharun, 2012). With innovations leading to improved outcomes/evaluations. • The basic form of the change evaluation survey, was developed through engagement with many lecturers (Porter, 2007), is indicative of face, construct and content validity. • Methodological triangulation involved the quantitative analysis of performance triangulated with qualitative responses from open ended questions.
Postgraduate Student Survey	• This involved basic open-ended questions • Its development was based on both the artifact analysis and the literature review to their use of the different software packages that are supported by UOW and available either at the SMAS computer laboratory or in their desktop computer ensuring content validity. • The questionnaire was first reviewed by experienced specialists (supervisors) and with modifications made and items added as suggested addressing face validity, content validity and construct validity.
Academic staff interviews	• Investigators triangulation use different sources of information to develop the postgraduate student survey and staff interview. The questions were developed following artifact analysis of e-Learning websites, the literature review and the in situ identification by staff of the software that they used and why they used it • Environmental triangulation involved using physical evidence of software in laboratories, confirmation by technical support people regarding availability of software, followed by confirmation of use by staff and students • Both experts made revisions, and feedback from the statistics expert addressed when revising questions.
Semi-structured interviews with staff developers	• The first set of questions ascertained demographic features of the interviewees, allowing the researcher to determine the sectors in which the developers worked Questions addressing these areas were open ended, used to give the researcher opportunities to investigate views and opinions of the interviewee • Experts from professional development area at UOW made revisions, and feedback and modification for some items or delete or added more items. Supervisors also vetted questions asked. • Interpretation of their comments, analysis was returned to participants for confirmation.
Training Evaluation Form	• Parry and Berdie (2004), evaluate for each Course level Satisfaction, Opinion, Knowledge Acquisition, Knowledge Comprehension, Skill, and to ensure construct, content and face validity each of these were addressed in the evaluation form, as were items from the Kirkpatrick model together with items from evaluations of UOW professional development programs. Experts (supervisors) also reviewed the training evaluation forms.
Student survey of experiences with the use of Tablet PC technology	• The issue of construct validity and face validity were addressed by ensuring evaluation of items as to how to improve were accord with the Parry and Berdie (2004) model and further extended to include aspects covered by the Kirkpatrick model (2006). Experts in the area (supervisors) were asked to vet the questions for appropriateness. The lecturer also reviewed the questionnaire before it was given to students, lending further support for the validity of the instrument.

3.1.5 Triangulation

Triangulation is a method used by qualitative researchers to check and establish validity in their studies by analyzing a research question from multiple perspectives (Guion, Diehl & McDonald, 2002), using multiple methods, sources, theories, and/or investigators (Farmer, Robinson, Elliott & Eyles, 2006). Five forms of triangulation have been characterised:

- Data triangulation. This involves using different sources of information in order to increase the validity of a study (Guion et al., 2002) such as two types of reports or respondent groups (Farmer et al, 2006). Data triangulation may also be achieved by gathering data using different sampling protocols, contrasting data gathered at different times and settings. Variance in events, settings, times may bring to light revealing atypical data or recurrent patterns both of which may improve the confidence in the findings (Turner & Turner, 2009).
- Investigator triangulation. This involves using several different investigators in the analysis process (Guion et al., 2002).
- Theory triangulation. This involves the use of multiple perspectives to interpret a single set of data (Guion et al., 2002). It is also involves using alternative disciplinary or substantive theoretical lenses to view research findings such as stages of behavior change (Farmer et al., 2006)
- Methodological triangulation. This involves the use of multiple qualitative and/or quantitative methods to study the program (Guion et al., 2002). This might involve employing several types of qualitative approaches such as interviews, document analysis, focus group discussion (Farmer et al., 2006). Qualitative data is often used to ‘‘explain’’ or add depth to quantitative findings, therefore, combining qualitative and quantitative methods may help the researcher to eliminate competing explanations (Turner & Turner, 2009).
- Environmental triangulation. This involves the use of different locations, settings, and other key factors related to the environment in which the study took place, such as the time, day, or season (Guion et al., 2002).

The advantages of triangulation include *“increasing confidence in research data, creating innovative ways of understanding a phenomenon, revealing unique findings, challenging or integrating theories, and providing a clearer understanding of the*

problem" (Thurmond, 2001, p. 254). The disadvantages include "possible disharmony based on investigator biases, conflicts because of theoretical frameworks, and lack of understanding about why triangulation strategies were used" (Thurmond, 2001, p. 256).

In this thesis the data used is generated from a mixed method that included data, methodological and environmental triangulation. For example, investigator and environmental triangulation use different sources of surveys results from well-known organizations for regions in developing countries. In addition, methodological triangulation involved using a variety of tools and processes to collect data such as artifact analysis (student websites and university websites), survey, observation, interviews and student assessment as documented in Section 3.1.3 while environmental triangulation involved gathering multiple perspectives from students and staff in multiple locations.

3.1.6 Strategies and research methodologies

In this study several methodologies were used to ensure the trustworthiness of the data. The study began with an immersion of the researcher into the Australian tertiary context, using the contrasts between the Australian and Libyan experiences to guide three case studies. As a participant, the positioning of the researcher to identify her role, potential biases or what she brought to the study was an important first step in the action research cycles where artifact analysis (refer Section 3.1.6.4) and reflection (refer Section 3.1.6.5) on outcomes informed the next cycle.

In this section different research strategies are discussed such as case studies, participant researcher and positioning of self, action research and artifact analysis. In this study through, combining qualitative and quantitative approaches, the triangulation of findings drew on several approaches, case studies, participant-researcher and positioning of self, action research, artifact analysis at all times paying attention to ethical considerations

3.1.6.1 Case studies

Harling (2012) define the case study as "a holistic inquiry that investigates a contemporary phenomenon within its natural setting" (p.1). As Harling explains, the terms refer to

1. *The phenomenon such as a program, an event, an activity, a problem or an individual(s).*
2. *The natural setting is the context within which this phenomenon appears.*
3. *Holistic inquiry involves collection of in-depth and detailed data that are rich in content and involve multiple sources of information including direct observation, participant observations, interviews, audio-visual material, documents, reports and physical artifacts (p.2).*

The purpose of such case studies is to provide,

> *an in-depth examination of one individual or single, direct social unit.... which provides an opportunity for investigator to develop insight into basic aspects of human behaviour.... which may lead to the discovery of previously unsuspected relationships (Ary, Jacobs, & Razavieh,1996, p. 484).*

Case studies have no specific methods of data collection or of analyses. One study may use questionnaires, another interview, observation or documents (Bassey, 1999). Educational case studies may have different orientations, "*theory-seeking, theory-testing, story-telling, picture-drawing and evaluative case studies*" (Bassey, 1999, p. 58). They are useful because of,

> *their strong procedures for fostering new hypotheses; their value as useful means to closely examine the hypotheses role of casual mechanisms in the context of individual cases; and their capacity for addressing causal complexity (George & Bennett, 2005, p. 19).*

Through these types of analyses, case study data collections allow the researcher to explore important characteristic of each case. Case studies can be used to create plausible explanations of what is found; to test the reliability these explanations to construct a worthwhile argument or story; to relate the argument or story to any relevant research in the literature; to convey convincingly to an audience this argument or story; to provide an audit trail by which researchers may validate or challenge the findings or construct alternative arguments (Scott & Morrison, 2007).

This research, has involved three case studies, with the first two leading to the third case study (refer, Section 1.7), described in more details in Chapters 4-6, and with the methodological approach described in Sections 3.2- 3.5.

3.1.6.2 Participant researcher and positioning of self

One of the strategies of enquiry used in this thesis has involved the researcher as a participant in the research. In qualitative methodology the researcher plays a direct and intimate role in both data collection and analysis (Dwyer & Buckle, 2009). If,

the researcher is an insider, then he or she shares the characteristic, role, or experience under study with the participants; as an outsider to the commonality shared by participants, the personhood of the researcher, including her or his membership status in relation to those participating in the research, is an essential and ever-present aspect of the investigation (Dwyer & Buckle , 2009, p. 55).

In qualitative research, the researcher has "*presupposition, choices, experiences, and actions during the research process*" (Mruck &Breuer, 2003, p. 3). Harrison, MacGibbon & Morton (2001) note that

…how the researcher's own experiences, values, and positions of privilege in various hierarchies have influenced their research interests, the way they choose to do their research, and the ways they choose to represent their research findings (p. 325).

Researchers inevitably have a relationship with the subject they are studying; they choose the research questions, decide what to measure, how to measure, when to measure, how to interpret and how to communicate findings (Swift & Tischler, 2010). Positioning oneself is the,

..discursive process whereby people are located in conversations as observably and subjectively coherent participants in jointly produced storylines (Davies & Harre´, 1999, p. 37).

Throughout this study I, the researcher has drawn on my experience as a mathematics lecturer in Libya. My mathematics teaching experience includes: a teacher in public education in Libya, from November 2001 to June 2006, and then as a mathematics teacher at a specialized boy high school in medical sciences with students aged 15 to 16 years (equivalent to school years 9 and 10 in the Australian education system). I also worked as an academic staff member in the Faculty of Arts and Science-El-hezam University branch of Garyounis University from July 2006 until taking leave to study in 2009.

In terms relevant to this thesis, I have two years experience teaching at the tertiary level in Libya in a subject which is the equivalent of the UOW subject MATH151 that was the subject used in the first case study. As the researcher I engaged in the role of developer of eLearning materials and website designer for this subject. This role as designer was also influenced by work as a casual research assistant developing mathematics video resources in the School of Mathematics and Applied Statistics UOW with four lecturers including one from Learning Development. These four lecturers have shaped the creation of videos and had input as to their use in

design.

> *Lived experience leads to self-awareness that acknowledges the integrity of an individual life and how separate life experiences can resemble and respond to larger public and social themes, creating a space for storytelling, interpretation and meaning making. Lived experience allows a researcher to use a single life to learn about society and about how individual experiences are communicated…. Lived experience offers a perspective through which to make comparisons for research and serves as a testimonial to survival….. The method concentrates on what people do and how they do it. (Boylorn, 2008, p.489).*

In Libya the teaching and learning environment of the classroom is teacher centred, using traditional and classroom teaching methods with whiteboards. As a consequence of being immersed in Australian culture, I was confronted with the limited learning supports for students in Libya such as group discussion, peer learning and eLearning support. In Libya there was an absence of using eLearning systems as a support for teaching and learning and little use of mathematical software. This stark contrast led to a questioning as to the scope of technology use which was outside the *Redesign of eLearning site* for MATH151 case study. This led thereby to the second case study investigating what technology was used, how and why it was used. This led ultimately to the final case study developing and evaluating a professional development program for mathematics staff in the Middle East regarding eLearning, the use of the Tablet PCs and the production of video learning support resources. Major influences come from reflection on my country of origin, Libya, and my knowledge of Middle Eastern culture, and education and my experience of everyday life in both the Middle East and Australia. My development and evaluation of a professional development package to create a good quality of education through the integration of technology into teaching and learning is guided by the cultural and educative needs of Middle Eastern participants, in particular, the need to create a positive learning support environment to facilitate students' learning.

As researcher I recognize that my research is influenced by my background, culture and experiences, with influence evident from the selection of the research question to the methodological perspective, of seeking to generate explanations from the experience of the participants.

3.1.6.3 Action research

Action research may be defined as "*about undertaking action and studying that action as it takes place*" (Coghlan & Shani, 2005, p. 533), while Boog (2003) focuses on purpose and outcome,

> *action research is designed to improve the researched subjects' capacities to solve problems ... increase their chances for self-determination and to have more influence on the functioning and decision making processes of organizations (p. 426).*

One representation of the action cycle involves four steps acting, developing, reflecting and planning. Mertler (2012), explained the four stages in the action cycle as the:

- *Planning stage involving identification of the issue to be changed and limiting the topic, gathering information, reviewing the related literature and developing a research plan.*
- *Acting stage involving implementation of the plan, collecting data and analyzing the data.*
- *Development stage involving development of an action plan.*
- *Reflecting stage involving sharing and communication of the results and reflecting on the process. (p. 36).*

The researcher engaged in several such cycles of planning, developing, taking action and examining the results (Refer, Section 3.1.9 Research Design).

3.1.6.4 Artifact Analysis

> *Artifacts become data through the questions posed about them and the meanings assigned to them by the researcher. There is no one right way to analyze artifacts…. In the process of analysis, we are asking the data to tell us something. An artifact has a story to tell about the person who made it, how it was used, who used it, and the beliefs and values associated with it (Norum, 2008, p. 23).*

Artifact analysis is a particular process of cultural investigation that uses objects as primary data to study the ideas, attitudes, beliefs, and values of a particular society at a given time (Hodges et al., 2007). Artifacts can provide for "thick description" of people and or setting and the story they can tell is valuable (Norum, 2008). The term of thick description is used to characterize the process of paying attention to contextual detail in observing and interpreting social meaning when conducting qualitative research (Dawson, 2010).

> *A thick description of a social event or action takes into account not only the immediate behaviors in which people are engaged but also the contextual and experiential understandings of those behaviors that render the event or action*

meaningful. In case study research, thick description involves looking at the rich details of the case, sorting out the complex layers of understanding that structures the social world (Dawson, 2010, p 943).

In this thesis several artifacts are available for analysis, for example subject outlines, resources, websites, and lecturer notes. When analysing these artifacts the following questions are investigated: what activities, what resources and what learning supports are provided for each topic to be learned? what is the temporal and special alignment of these items in the website? and how do we design artifacts that work better?

3.1.6.5 Reflection

Schön's (1983) model presented the concept of two types of reflection: reflection-in-action (while doing something) involves, experiencing, thinking on your feet thinking about what to do next and acting straight away. Reflection-on-action (after you have done it) involves thinking about something that has happened, thinking what you would do differently next time and taking your time. Reflection involves looking to experiences, connecting with feelings, and attending to theories in use.

The practitioner allows himself to experience surprise, puzzlement, or confusion in a situation, which he finds uncertain or unique. He reflects on the phenomenon before him, and on the prior understandings, which have been implicit in his behaviour. He carries out an experiment, which serves to generate both a new understanding of the phenomenon and a change in the situation (Schön 1983, p 68).

Reflection-in-action allows reshaping what we are working on, while we are working on it. In "reflection-in-action,

…doing and thinking are complementary. Doing extends thinking in the tests, moves, and probes of experimental action, and reflection feeds on doing and its results. Each feeds the other and each set boundaries for the other" (Schön, 1983, p. 280).

Making changes to practice for the purpose of improvement directly relates to reflective practice, which Schön (1983) considered a central component of reflective thought. Schön (1983) explained that as

The practitioner allows himself to experience surprise. . . . He reflects on the phenomenon before him. . . . He carries out an experiment which serves to generate both a new understanding of the phenomenon and a change in the situation (p68).

The experience of being a researcher from another country with a different cultural background highlighted experiences, causing reflection-in-action, particularly with

respect to differences in how things were done in Australia when compared to Libya. Reflection-in-action in this study enabled finding out what was different and how it could be changed.

Reflection-on-action in this design study is provided by final reflection in which evaluate own process.

> *We reflect on action, thinking back on what we have done in order to discover how our knowing-in-action may have contributed to an unexpected outcome (Schön, 1983, p. 26).*

3.1.1 Ethical considerations

Research ethics is an attempt to resolve not merely general issues but also specific problems that arise in the conduct of research (Peach, 1995) before that research is undertaken. When employing human subjects, ethical considerations are paramount, in ensuring that the research is conducted in an ethnical manner (Kervin et al., 2006). Ethical clearance was successfully obtained for research in each stage of the three case studies used from the UOW Human Research Ethics Committee (HREC).

To address the University's ethical guidelines for research the researcher needed to inform participants through *Participant Information Sheets* as to the nature and purpose of the research, the procedures involved and their rights. In addition a *Consent Form,* as detailed in each case study, is used that documented their agreement for an interview to be recorded to ensure an accurate recording of responses. Participation was not compulsory in any of the case studies but encouraged because of the anticipated benefits for students and staff. To ensure confidentiality of research data the researcher and principal supervisor were the only people who could access the data. Furthermore, the student survey was completed anonymously. Real names of staff interviewees have not been used in any publication or in this thesis. Staff also gave permission for interview excerpts to be included in this thesis and/or any publications to come from the research, with the understanding that quotations would be either confidential or attributed to them only with their review and approval.

3.1.2 Data collection techniques

Within the framework of conducting a case study many data collection tools can be used. Two common techniques for the collection of data are the survey or

questionnaire and semi-structured interviews. A third data measurement tool, often used in educational research, is a measure of performance or learning outcomes, such as provided by marks in student assessment and examinations.

3.1.2.1 Surveys

The basic concept of survey research involves capturing beliefs, attitudes, or outcomes that can be generalized to the population from which the sample was selected (Alderman and Salem, 2010). Aaron (2012) discusses the benefits of using a survey in a research study. These include:

- *Collecting data with a survey is efficient because it can be administered to many individuals at a single time in person, via the Internet, over the phone, or through direct mail.*
- *Data is easy to analyze and can be used to describe the population of interest. Some methods of survey research, such as the Internet, can be inexpensive and help to keep the research budget reasonable.*
- *Surveys make data collection easy because they are fairly easy to administer to a sample and the results then can be generalized to a population (p. 190).*

In developing a survey the researcher needs to consider the purpose, the sampling methods, the collection of data, including the design of the survey, and the analysis of data:

- Purpose. For any research study a researcher should decide the purpose. That is the overall goals and objectives of the research (Aaron, 2012). There are two different kinds of survey goals: descriptive and explanatory (Goodman, Kuniavsky, Moed, 2012). Descriptive goals aim to profile the audience. They summarize the audience's composition in terms of their personal characteristics, what they own, what they want, and how they claim to behave (Goodman et al., 2012). Explanatory goals explain people's beliefs and behaviors by uncovering relationships between their answers (Goodman et al., 2012).
- Sampling. The best representation of a population of interest comes from drawing a random sample or allocating students to groups through such a process. This is often not possible in educational research, particularly if experimental manipulation for ethical reasons is not possible. In this study the students who respond are essentially volunteers, for example, those in class when the data were collected, and as such there are limits to the

generalizability of the data.

- Design of the survey. There are many considerations in the design of surveys, commencing with the design of an information sheet as an introduction and instructions for the participants, the design and structuring of questions to ensure they are clearly worded and easy to understand and address the research issues. The medium for delivery also needs to be chosen, for example printed on paper or delivered online.
- Construction of Questions. Three basic types of questions can be asked: multiple choice, numeric open-ended and text open-ended. Characteristically, questions relate to behaviour and attitudinal questions (Goodman et al., 2012) in addition to questions regarding subject demographics.
- Collecting and analyzing data. When the data has been collected, it is then entered into a relevant, well-established, validated software package, in this study SPSS. The researcher begins a basic analysis of the survey results in terms of frequency tables and descriptive statistics as described for each case study in Chapters 4-6.

3.1.2.2 Semi-structured interviews

The main feature of the interview method, often the main method for collecting empirical data of relevant practices, is to facilitate the interviewees sharing their perspectives, stories and experience regarding a particular social phenomena being observed by the interviewer (Wahyuni, 2012). Qualitative research interviews provide access to the experiences, feelings, and social worlds of participants (Fossey et al., 2002). Interviews are particularly useful when rapport between the researchers and respondents ensures confidence, or in instances when privacy may alleviate fear of reprisal for negative statements, such as program evaluation or patient satisfaction studies (Curry, Nembhard & Bradley, 2009). A semi-structured interview offers the merit of using a list of predetermined themes and questions as in a structured interview, while keeping enough flexibility to enable the interviewee to talk freely about any topic raised during the interview (Wahyuni, 2012). For these, the interviewers use an interview guide to facilitate a more focused exploration of a specific topic, or to follow up on specific issues that emerge during data collection (Fossey et al., 2002).

Roulston (2010) summarize four inter-related facets of research which pertain to the quality of the interview data:

1. *The use of interview data is an appropriate means to inform the research questions posed;*
2. *The interaction facilitated by interviewers within the actual interview generated 'quality' data, for example, interviewers asked questions in effective ways to elicit the data required to respond to research questions, and both speakers adequately understood one another's intended meanings;*
3. *Quality has been addressed in research design, the conduct of the research project, and the analysis, interpretation and representation of research findings; and*
4. *The methods and strategies used to demonstrate the quality of interpretations and representations of data are consistent with the theoretical underpinnings for the study (p. 202).*

In developing an interview or a semi-structured interview the researcher, in a similar fashion to survey development needs to consider the purpose, the sampling methods, the collection of data including the design of the survey and the analysis of data:

- Purpose. Semi-structured interviews focus on specific themes for learning about the motivations behind people's choices and behaviour, their attitudes and beliefs, and the impacts on their lives of specific policies or events (Master, 2012).
- Sampling. "*Selecting appropriate candidates for interviews who will be willing to openly and honestly share information or "their story" is important*" (Creswell, 2007, p. 133). The selection of participants to be interviewed, whether lecturers, postgraduate students or staff developers, was undertaken using a snowball sampling scheme. Snowball sampling is defined by Atkinson and Flint (2001) as,

  > *a technique for finding research subjects. One subject gives the researcher the name of another subject, who in turn provides the name of a third, and so on. This strategy can be viewed as a response to overcoming the problems associated with sampling concealed hard to reach populations such as the criminal and the isolated (p. 1).*

- The advantage of snowball sampling is the ability to recruit hidden populations (Miller, Strang & Miller, 2010). The disadvantages are that oversampling a particular network of peers can lead to bias and also that respondents may be hesitant to provide names of peers, and asking them to do so may raise ethical concerns.

- The interview questions. Interview questions are structured to include open-ended main questions, follow-up questions and probes (Wahyuni, 2012). Follow-up and probing questions attempt to extend the subjects' answers through the inquiring, persistent and occasionally critical attitude of the interviewer (Qu & Dumay, 2011). These questions should be developed to explore the particular themes, concepts, ideas and unexpected thoughts provided by the interviewees, with probes to keep the discussion flowing and to clarify discussion points by asking for more details or examples of what had been said (Wahyuni, 2012).
- Preparation for the Interview. The preparation stage includes: choose a setting with little distraction; explanation of the purpose of the interview, confidentiality, the format of the interview, how long the interview usually takes, how to get in touch with the interviewer if they want to ask questions; asking the interviewee if they have any questions before the start of the interview and ensuring appropriate recording so that the researcher does not have to rely on memory to recall interviewees answers (McNamara, 2009).
- The Interviews. The researcher begins the interview by briefly explaining the aim of the interview and emphasizing the confidentiality, anonymity (Wahyuni, 2012). Semi-structured interviews for staff at a departmental level were used in the second and third case study. These were digitally recorded with the informed consent of the interviewees. While the data was collected in confidence, and intended for reporting using pseudonyms, because the analysis is by year and subject matter, absolute anonymity cannot be guaranteed in the local context; interviewees were made aware of this.
- Data analysis. Once the interviews are completed, transcription is undertaken. Interview data is used to identify themes that have arisen and at times to support or contrast with quantitative data gathered in surveys. Thematic analysis is a method for identifying, analysing and reporting themes within data. It organizes and describes the data set in rich detail (Braun & Clarke, 2006). Thick description is used to illustrate the points that arise. The notion of thickness deals with fine-grained accounts, contextualization, the combination of multiple perspectives and reflexivity (Usunier & Sbizzera, 2013).

The researcher's desire to be sensitive to the use of ideas generated from interviews and the need to provide trustworthy interpretations meant that transcribed interviews were returned to staff, so that staff could withdraw or correct any comments and information they provided.

3.1.2.3 Performance Assessment

Student assessment is a key measure of student performance. Assessment is a significant aspect of learning for both teachers and students (Cook, 2001; Diaz & Bontenbal, 2001). For the educator it has a powerful impact on what is taught. It provides information about students' starting points, progression and the effectiveness of teaching throughout the teaching process, and, at the end the readiness of students to progress (Cook, 2001). Cook argues that for the learner it shows what is valued as a learning outcome and provides information to the individual student about current knowledge and skills in relation to a required standard (Cook, 2001).

Assessment can provides a variety of information about student learning. Possible assessment tools include tests, questions, observation, discussion, group projects and peer/self assessment. Diversity in the types of assessment allows a variety of different learning outcomes to be assessed and ways to guide students in their learning (Cook, 2001). A *Good Practice Assessment* site at UOW provides guidance to academic teaching staff in how to appropriately assess students (Good Practice Guides, 2013).

3.1.3 Research design

> *Historically, design in educational research has served as a way to implement theories for testing. The emerging design research paradigm treats design as a strategy for developing and refining theories (Edelson 2002, p. 105).*

A research design is important to connect a methodology and an appropriate set of research methods in order to address research questions and/or hypotheses that are established to examine social phenomena (Wahyuni, 2012). According to Punch (2009) the research design is the basic plan for pieces of research and includes four main ideas: what strategies; what framework; who or what will be studied; and what tools and procedures will be used to collect and analyse the data. The three case studies, their aims, strategies for data collection in this study are summarized in

Table 3.4. *The Redesign of eLearning site* commenced in 2010, with data collection cycles and ended in July 2012. The *Technologies in Higher Mathematics Education* study commenced in 2011 involved the collection of interview data regarding the use of technology and identifies the approaches staff used in terms of self-development and staff development. The data obtained from the interviews in UOW provided rich details to compare and contrast against interviews conducted in Oman. The third and final case study, *Professional Development in the Middle East*, involved the development, implementation and evaluation of a professional development package delivered in February 2012 in Oman to raise awareness regarding the improvment of mathematics education through the use of technology.

Table 3.4 Research design

Case studies	Aims, strategies and data collection methods
Case Study 1 *Redesign of eLearning* (MATH151)	Aim: To develop an effective structure for embedding mathematics learning support into eLearning systems Guiding theoretical approaches: Behaviourism, cognitivism, constructivism and connectivism and learning design. Methodology: A mixed methodology for validation purposes involved methodological triangulation involving immersion (reflection) artefact analysis, interviews and surveys and the quantitative analysis of performance was used to triangulate on the student learning experience. Strategies used included: Immersion in online learning environment and analysis of artifacts associated with MATH151 Interviews and discussions with lecturer, *Next steps* Development of student survey, *Change Evaluation* Three action cycles of data collection 1. 2010 Baseline data collection (Change Evaluation & performance data) followed by analysis 2. 2011 First Redesign of eLearning site (Change Evaluation & Performance data) followed by analysis 3. 2012 Second Redesign of eLearning site(Change Evaluation & Performance Data) followed by analysis
Case Study 2 *Professional development for technology in mathematics education*	Aim: To identify what staff need in terms of technology and professional development Methodology: For the purposes of methodological triangulation to aid making sense of the use of technologies in teaching and learning a mix of surveys and semi-structured interviews were used and for data triangulation academic staff, staff developers and postgraduates were consulted. Immersion in technology context 2011 Semi-structured interview of postgraduates and staff 2011 Semi-structured Interview of Australian staff developers Drawing on experiences of Case Study 1 and analysis of Case Study 2 to identify the basis for a staff professional development package.
Case study 3 *Professional development in the Middle East*	Aim: Development, implementation & evaluation professional development package in Middle East Guiding theoretical approaches: Ellis model; community of practice and followup support. Methodology: For the purposes of methodological and environmental triangulation to aid making sense of the use of technologies in teaching and learning a mix of surveys and semi-structured interviews, workshops were used and for data triangulation academic staff, staff developers and postgraduates were consulted. Examination of the Libyan and Omani context 2012 Training at Sultan Qaboos University. Evaluation of training 2012 Survey Staff & Postgraduates at Omani math department 2012 Semi-structured interview of Omani math staff 2012 Semi-structured interview of Omani Staff developers Analysis and future recommendations

3.1.1 Analysis techniques

Artifact analysis was chosen as a means of accessing information that was documented in a manner that an interview would possibly not fully elicit. For examples, websites, subject and course descriptions are detailed in terms of the topics covered and the level at which they are taught and these in their entirety might not easily come to mind an interview. Similarly laboratories show evidence of the technologies in use. The reporting of such data involves thick description, and in some instances comparison of the evidence from the different cohorts of subjects or across the countries involved.

Qualitative data generated from interviews was recorded and transcribed. Content analysis was used to identify themes emerging from participants in both interviews and surveys as to the nature of their experience with technology and their desire for further use. Through a process of forming categories, splitting categories and reformulation as described by (Suter, 2011), themes were identified and reported.

Quantitative data was analysed using SPSS V17 for Windows. The data file so created was checked for accuracy and then analysed using:

- Frequencies. These were tallied and percentages were calculated for descriptive purposes.
- Chi-square analyses. These were used for example to determine if there were significant differences in the proportions of student groups feeling competent in a particular mathematics topic. For the analysis of data in such two-way contingency tables the expected counts were examined to ensure that the assumption, of a minimum expected count of 5 in each cell, was met. In some instances where there were multiple responses (scales 1-5), categories were often combined to form one category, for example, strongly agree *and* agree. Observations in the analysis of all such two-way tables were independent.
- The Sign Test. This is a nonparametric test for hypotheses about a population median given a sample of observations from that population, or for testing for equality of medians, or a specified constant median difference, given paired sample values from two populations (Sprent & Smeeton, 2007). The sign test is of use when it is necessary to know if observed differences between two conditions are significant (Kitchens, 2003). The sign test is so called because

it allocates a sign, either positive (+) or negative (–), to each observation according to whether it is greater or less than some hypothesized value, and considers whether this is substantially different from what we would expect by chance (Whitley & Ball, 2002). As is common practice decisions made as to statistical significance are reported using a 95% level of confidence, providing the p-value (p), the probability of obtaining of obtaining these results or more extreme under the null hypothesis, together with the degrees of freedom (df) used on the determination of significance.

3.2 Case study 1: Redesign of eLearning

Following a literature review which identifies the theoretical background of learning design and the impact of learning design on students at a university level, both important elements when considering the *Redesign of eLearning*, the methods for undertaking this redesign are detailed. Initially, the purpose of this case study was clarified and a process, known as a *Change Evaluation Process*, was identified to collect data. *Next Step* interviews and *Change Evaluation Surveys* were used to collect data once ethics approval was obtained. The data collected from these processes together with performance assessment formed the basis for an action research cycle. This involved the gathering of evidence, the planning and introducing of the redesign and the gathering of evidence to evaluate the eLearning redesigns. Following is a detailed examination of the various facets of the research process.

3.2.1 Purpose

The aim of this study has been to identify ways to improve student learning outcomes. This led to an examination of how to use visual representations of learning designs to better communicate the objectives of the topic chapters. It is also an exploration of the activities students must perform and the support that is available to help them to both complete the activities and to learn. More precisely the aim has been to:

1. Improve learning outcomes. Specifically enabling students to
    a. Improve performance
    b. Feel more confident or competent with learning mathematics.
    c. Value resources
    d. Gain time for learning through engaging with subject matter prior to the formal commencement of studies.

2. Design of eLearning. Identify potential strategies for improving the learning design, the combining of resources, tasks, activities and assessment in eLearning site so as to enable students to better learn and understand.

3.2.2 Research design: Change Evaluation Process

Porter (2007) describes a *Change Evaluation Process* for continuous improvement of subjects, identifying areas of strength and weakness and thus targeting areas of the subject where resources can be improved or replaced. This process has been used to guide and to assess the impact of changes to assessment (Morris, 2008) and learning designs (Baharun, 2012). The process draws on action research methodology, with cycles of planning, action, and examination of results. Riel (2010) argues that,

> *This form of research then is an iterative, cyclical process of reflecting on practice, taking an action, reflecting, and taking further action. Therefore, the research takes shape while it is being performed. Greater understanding from each cycle points the way to improved practice (p. 1).*

The study design involved three cycles: the baseline cycle; *Redesign 1;* and *Redesign 2* (refer, Figure 3.1).

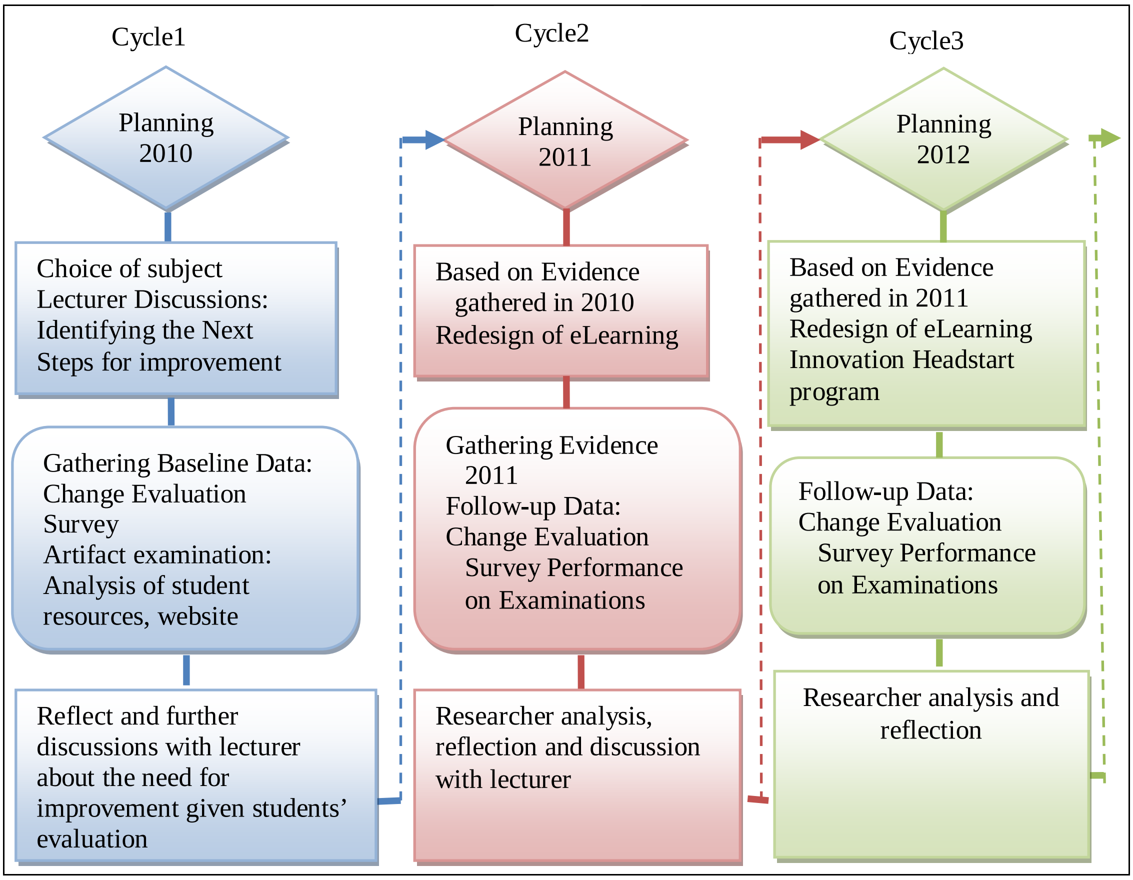


Figure 3.1 Action research cycles
Source: Adapted from Riel, M. (2010)

The first cycle involved a process of embedding the researcher into Australian Higher Education culture. In the first case study, this embedding involved working with online learning systems, developing video learning support resources and developing and evaluating learning designs for combining resources. From this experience the researcher was better able to examine and understand the literature and the available technology. The baseline phase in 2010 involved selection of a mathematics subject at UOW. The first data collection was to gather baseline information to evaluate the effectiveness of the initial eLearning pages and learning resources so as to provide a baseline for evaluating future changes.

The second cycle, the first redesign, in 2011 involved redesigning the MATH151 eLearning site based upon discussion with the main lecturers regarding their perceived next steps for improvement and the baseline data gathered regarding students evaluation of the eLearning pages. The functionality and usefulness of the site was addressed in the redesign with the online structure being modified and video orientation resources for the first five of eleven chapters developed and made available to students.

The third cycle, in 2012 involved a second redesign based on feedback from the second stage regarding the usefulness of the eLearning site. There was a complete redesign of the online structure and placement of resources. Orientation video resources for the remaining six chapters were developed and made available along with worked example for three chapters. In addition information was made regarding relevant available library reference books for each topic covered. A Head-Start program, which provided students with an optional two weeks of online work ahead of the formal start of subject, was also introduced.

Through baseline and follow-up evaluations the *Change Evaluation Process* provides a mechanism for measuring the impact of innovations or modifications made to improve learning outcomes. The process combines *Next Step* discussions with lecturers with a *Change Evaluation Survey* for students (Section 3.2.4).

3.2.1 Sampling

The choice of university for the study followed the earlier choice by the researcher to undertake graduate studies at the institution. That choice was based on the reputation

of the University. UOW is ranked in the top 2% of research universities in the world (QS World University Rankings 2011). In 2011, the SMAS according to the *Good Universities Guide* (http://www.hobsonscoursefinder.com.au/), based on responses from graduates from all universities in Australia, is ranked better than average on Teaching Quality and Overall Satisfaction and average on Generic Skills (http://eis.uow.edu.au/smas/news/UOW094572.html#news).

In the *Redesign of eLearning site* case study the researcher's starting point was the identification of a lecturer within SMAS, through supervisor recommendation and subsequent discussion with the nominated lecturer, as one who wished to improve student learning outcomes and was prepared to engage in subject development. In addition the subject, MATH151 was one where there was scope for improvement, for example in terms of having a high failure rate.

The student sample was drawn from students attending the final lecture of MATH151 (refer, Section 4.2.4). While most students in attendance on the final day of lectures voluntarily completed the surveys, the number of students attending class that day impacted on the proportion of students in the subject providing data.

3.2.1 Ethical considerations

Having determined who to sample, as discussed in Section 3.1.1 the collection of data in this study required ethics approval from the *University of Wollongong Ethics Committee*. Students were informed about the purpose of the study through a *Participant Information Sheet*. This sheet informed students that the goal of the study was to develop and improve learning resources, and hence the subject, in order to improve student outcomes. Additionally, it was explained that participation in the study was voluntary and that the outcomes of the study would be used to assist future students (refer, Appendix 1).

3.2.2 Data collection tools

The first of the data collection tools, as often happens in education research, involves students' examination and assessment results as a means to assess changes in performance. The data tools developed and used in the first case study were to complement the researcher's analysis of the students' learning context, the design of learning and the resources provided. The orientation given to the two data collection

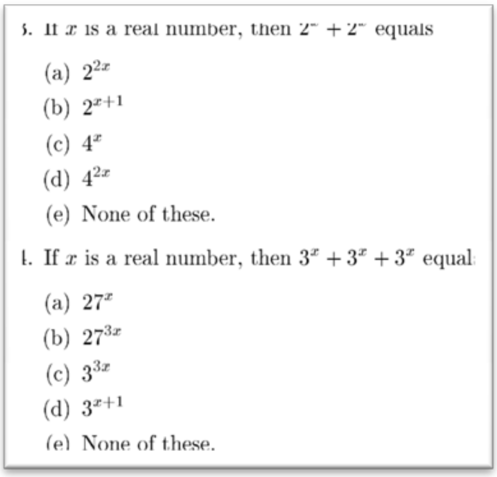
tools, the *Next Step* interview of the lecturer and the *Change Evaluation Survey* for students, was to identify potential strategies for improving student learning outcome.

3.2.2.1 The assessment scheme

In MATH151 the assessment involved five components, in-class tests, tutorial assignments, online quizzes, group research project and a final examination. The four forms of assessment to provide variety and help to promote ongoing work throughout the session:

1. Quizzes, tests and examinations. The type of learning to be demonstrated in quizzes and all tests/examinations involved calculation, problem solving, application of procedures and demonstration of techniques, knowledge and understanding and a minor level of interpretation. Students were allowed to bring their own double-sided formula sheet to tests and examinations.

   a. Online quizzes involved multiple choice questions accessible through the eLearning system (refer, Figure 3.2). Each test contains ten questions and students are shown each question one at time. A student has thirty minutes to complete the test. Students can take each test only once and each student receives a different test.



If x is a real number, then $2^x + 2^x$ equals

(a) 2^{2x}
(b) 2^{x+1}
(c) 4^x
(d) 4^{2x}
(e) None of these.

If x is a real number, then $3^x + 3^x + 3^x$ equal

(a) 27^x
(b) 27^{3x}
(c) 3^{3x}
(d) 3^{x+1}
(e) None of these.

Figure 3.2 Sample of online quiz

   b. In-class tests consist of two parts short answer and long answer (refer, Figure 3.3).

....

Part A: Short Answer Questions

Show full working to the following problems in the space provided. Each question is worth one mark.

1. Solve the expression $\frac{1}{x} = \frac{1}{y} + \frac{1}{q}$ for x.

Part B: Longer Answer Questions

Show full working to the following problems in the space provided.

1. One form of the van't Hoff isotherm is:

$$K = \exp\left[-\frac{\Delta G^0}{RT}\right],$$

where K is an equilibrium constant, ΔG^0 is the corresponding value of the change in the Gibbs function, R is the ideal gas constant and T is the temperature, measured in Kelvins.

(a) Determine the value of K when $\Delta G^0 = 4000\,\mathrm{J\,mol^{-1}}$, $R = 8.314\,\mathrm{J\,K^{-1}mol^{-1}}$, and $T = 298$ K. [1]

(b) By taking logs and simplifying show that this equation can be written in the form

$$\ln K = \frac{m}{T} + n,$$

identifying the values of the parameters m and n. [2]

(c) Rearrange the van't Hoff isotherm to make ΔG^0 the subject of the equation. (Hint. Use your answer to the previous question). [2]

Figure 3.3 Sample questions in class test

2. Tutorial assignments. The composition of the tutorial assignments includes mathematics questions and action questions, that is mathematics questions as applied in science. The tutorial assignments focus on long answer questions. Students were given more questions to be worked than marked. Although only ten questions were marked, students were provided with solutions for all questions so they could check all answers/solutions. Since 2010 the tutorial assignments, associated with the tutorial class as the place for submission have been designed to include the previously existing mathematics questions and in addition action questions, that is mathematics questions as applied in science.
3. Final examinations. As for tests, in the final examination students are allowed to bring a one-page, A4-sized, double side summary sheet. In both, students are allowed to use single-line-display calculators. The duration of the final examination is three hours and the exam consists of two parts. The first part is 20 multiple choice questions with a value of 20 marks. The second part is working problems including all necessary reasoning with a value of 40 marks.
4. Optional Group Research Project. In accord with the theory that collaborative learning activities lead to active and meaningful learning environments (Oliver & Herrington 2001) the lecturer, in 2010 introduced the project as a new way to engage learners through optional assessment where students

discuss an application of mathematics in science and present it in class (refer, Table 3.5). Worth 10 per cent of the overall weighting, the learning outcomes for the project related to the need to communicate, design, create, perform, and to think critically, making judgments about the topic they choose. Students are able to supplement traditional assessment by collaborating on a project to investigate the importance of mathematics in science.

Table 3.5 Group project assignment

Group project assignment	
Date	Week 13 (TBA).
Value:	10% of final mark
Marking:	Student mark will contain a group component (75%) and an individual component (25%).
Duration	5 minutes
Group size	Four students. Limited number of groups allowed. Group should contact subject coordinator in Week five.
Format:	Choose an aspect of science that applies some mathematics taught in MATH151. Report on the aspect of science, the mathematics that is required and how the mathematics is used.
Presentation	Students using PowerPoint and report will take the form of a five minute presentation

* Data source: MATH151 March/Autumn 2013

Students were allowed the best mark from two alternative weightings of their assessment as presented in Table 3.6.

Table 3.6 The assessment components

Assessment	No	Alternative weightings		Descriptions
		Weight 1	Weight 2	
In-Class Tests	3	30%	30%	▪ Duration 50 minutes. In weeks 4, 8 & 12 ▪ Students have an option of re-sitting the week 4 & 8 tests in weeks 6 & 10 respectively. The re-sit paper is a different test to that originally given. ▪ For those students who re-sit a test their best mark is used to determine their final mark.
Tutorial assignments	3	10%	10%	▪ Handed out in weeks 2, 6 & 10. ▪ Submitted in weeks 4, 8 & 12.
Online quizzes	3	10%	10%	▪ Ten questions in thirty minutes weeks 4, 8 & 13. ▪ The quiz opens at 8 am on the Sunday of the week and closes at 5:30 pm on the Friday of the week. ▪ Each student receives a different test
Group Research assignment	-	-	10%	▪ Student group size four. Choose any aspect of science that applies mathematics as taught in MATH151. ▪ Report on the aspect of science, the mathematics that is required and how the mathematics is used. ▪ Student groups give five minute presentations in Week 13. ▪ The mark contained a group component (75%) and an individual component (25%).
Final Exam		50%	40%	▪ Duration 3 hours
Total		100%	100%	

3.2.2.2 Changes to assessment

The lecturer taught the subject for the first time in 2007 and made incremental changes to assessment from 2008 to 2010. Initially the assessment regimes were those inherited from the previous lecturer. Recognising that very weak are students

nervous about mathematics and are not very confident when confronting an examination, the examination has been reduced in value from 70% to a possible 40% by the commencement of this study. The assessment for the most part was consistent over the three years of this study 2010-2012, with a change to the number of tutorial assignments, with the first tutorial assignment omitted (refer, Table 3.7).

Table 3.7 Changes of the assessment scheme

	In-Class Test (3)	Tutorial assignments	Online quizzes (3)	Group research project	Final Exam
2010	▪ 30% (10% of final mark each) ▪ Week 4,8,12 ▪ In week 6, re-take in-class test from week 4 ▪ In week 10 re-take in-class test from week 8	▪ Total of 10% ▪ (4) Assignments handed out in week 1,4,8,10 ▪ Handed in week 3,6,10,12	▪ Total 10% ▪ Week 4, 8, 13	10%	50% or 40%
2011	Same	▪ Total of 10% ▪ (3) Assignments handed out in week,4,8,10 ▪ Handed in week 6,10,12	Same	Same	Same
2012	Same	▪ Same as 2011	Same	Same	Same
2013	Same	▪ Same as 2011	Same	Same	Same

The validation of assessment followed principles recommended for educational assessment.

> *"The educational design of a program is validated by checking that the characteristics of assessment methods/tasks across the program are well-defined and are aligned with the requirements of the competencies and/or learning experiences. Assessment activities for new, amended or varied courses:*
>
> - *are consistent with the competencies/module learning outcomes, and assessment context and learning activities as appropriate;*
> - *are fair with respect to weighting and timing of assessment across the program;*
> - *use clearly specified marking criteria where graded assessment occurs, which are at an appropriate standard and comply with the procedures for graded assessment in competency based … programs;*
> - *will include agreed judgements by assessors about how to interpret (a) evidence of competence and/or (b) marking criteria for grading, in order to maximise consistency, and ensure fairness and reliability"*
>
> (http://www.rmit.edu.au/browse;ID=ik661ngu366r;STATUS=A;PAGE_AUTHOR=Andrea%20Syers;SECTION=1);

The development of assessment at the University of Wollongong is guided by a Good Practice-Assessment guide (http://www.uow.edu.au/about/policy/UOW058614.html). The School Education Committee within the School of Mathematics and Applied

Statistics approves major changes to assessments. No major changes were undertaken. With respect to the breakdown of assessment, in accord with departmental procedures a second expert, the subject assessor, checks the breakdown of the assessment to ensure it complies with university regulations. Two experts in addition to the lecturer check the final examination with respect to the appropriateness of the assessment in terms of the competencies required and ensuring a fair weighting of topics and time to assess. A final administrative check is conducted to ensure that there are no errors with page numbering, formatting of the paper. To ensure reliability, a range of assessment methods and tools were used at different points throughout the course.

3.2.2.3 Identifying lecturer's Next Steps

The *Next Step* interview involved discussion with the lecturer identifying: 1) what the lecturer perceived to be the next steps for improving the subject; and, 2) relevant contextual information, such as the current resources available to students and their function. The latter enabled the development of the *Change Evaluation Survey* wherein students are asked to evaluate current learning resources in addition to providing suggestions as to how the subject could be improved.

Understanding what motivates students learning online is important if lecturers are to help students to improve their performance. However there is limited research on how to build eLearning programs that activate and sustain adult students' motivation (Taran, 2005). To motivate students and to improve student performance in an eLearning setting Keller's and Suzuki (2004) ARCS Model focuses on attention, relevance, confidence and satisfaction. When designing instruction material Keller uses graphics and animation to gain learner attention. Keller and Suzuki also emphasises relevance, the need to set clear goals and the need for learners to gain positive feelings about their learning experiences. Further, students need to be kept informed of their progress towards meeting these goals (Hodges, 2004).

The lecturer's next steps were formed on suspicions based on encounters with students, and a logic that suggested that with multiple resources the design of the online component of the subject needed to be improved. The lecturer identified the resources currently used in the subject (for example, tasks, video clips), assessment, the structure of the subject, the major topics taught and the learning outcomes desired

together with the lecturer's perspective as to what needed to be changed in order to improve the subject. With this came the suggestion that additional video resources to support learning could be useful. Questions were developed for the *Change Evaluation Survey* to assess whether these "next steps" were appropriate from the student perspective.

The lecturer's identification of resources and assessments was confirmed with an examination of the subject's artifacts: the subject outline, the eLearning site and observation of the functioning of MATH151. A variety of resources made available to students as summarised in Table 3.8. The use of these resources was investigated in the *Change Evaluation Survey*.

Table 3.8 Resources available for students

Resources	Description / Function
Textbook	11 printed chapters of lecture notes covering an introduction and topics: indices, logarithms, function notation, straight lines, trigonometry, exponential growth and decay, data modelling, limits, differentiation & integration.
Lectures	Explained theory followed by worked example and interaction with students
Tutorials classes	Began in week two and covered practice examples
eLearning	The main purpose was to provide access to resources, combined in ways that supported student learning.
PASS (Peer Assisted Study Sessions)	This is an academic mentoring program run by an experienced senior student. PASS beginning in week 2 has a strong record of helping struggling students to get through math subjects. http://www.uow.edu.au/student/services/pass/index.html
Consultation	One-to-one consultation and small group sessions are available
Coordinator's web-page	Web-page designed by the coordinator of the subject (http://www.uow.edu.au/~mnelson/teaching.dir/math151.html).
Summertime Math	An online repository of mathematics learning resources allowing students to identify specific skills required for their first session of tertiary mathematics studies and to review those skills before starting their subject at university (http://www.math.uow.edu.au/subjects/summer/topics/logs.html)

3.2.2.4 The Change Evaluation survey

The *Change Evaluation Survey* "was designed to elicit student perspectives" on how to improve the subject". The data gathered from students is used to identify which of the subject resources have the greatest potential for improvement or replacement.

> *The core components of the questionnaire included questions about: how students undertook their study; ratings on how valuable the learning resources were in terms of helping them learn and understand; ratings of their perceived competence in the major topic areas; student perspectives on how to best improve the subject; either student marks on some assessment or a question on the expected grade for the subject; and demographic information to allow comparison of student preferences for resources (Porter, 2007, p. 6).*

The main section of the survey instrument was split into a number of question sets addressing both student demographics, and student learning outcomes in terms of the usefulness of resources to help students learn and understand, and how students

perceived their competency:

- Student demographics. Reflecting concern about equity of access to learning, the *Change Evaluation Survey* includes questions regarding demographic information and the students' patterns of study, their status as an international or domestic student, and gender.
- Perceived Competency. Students perceived competency in the major topics, as listed in Table 3.9, identified by the lecturer were evaluated. Perceived competency, interpreted as student confidence regarding the topics taught, was assessed with a view to identifying the areas that might need additional or modified resources.

Table 3.9 Students' confidence with topics

Confidence in the subject: How confident are you that you can solve problems involving?	Not at all	Have a little difficulty	Moderately confident	Could do this
Fractions	1	2	3	4
Algebra	1	2	3	4
Indices	1	2	3	4
Logarithms	1	2	3	4
Function notation	1	2	3	4
Straight lines	1	2	3	4
Trigonometry	1	2	3	4
Exponential Growth and decay	1	2	3	4
Data Modelling	1	2	3	4
Limits	1	2	3	4
Differentiation	1	2	3	4
Integration	1	2	3	4

- Usefulness of resources helping understanding. Evaluation of resources was in terms of helping students *understand*. All resources (lecturers, notes, assessment…), as detailed in Table 3.10 and identified by the lecturer in the *Next Step* interviews, were evaluated in terms of how those resources help students *understand*. This form of questioning can also be adapted to gauge the impact on different outcomes such as student anxiety and confidence (Baharun & Porter 2009; Baharun, 2009).

Table 3.10 Usefulness of learning resources

Usefulness of Learning Resources How useful are the existing resources in helping you understand in this subject?	Rarely used	Little use	Moderately useful	Extremely useful
Lectures	1	2	3	4
Lecture Handbook (chapter 0- chapter 10)	1	2	3	4
Consultation with lecturer	1	2	3	4
Work in Practical classes	1	2	3	4
Tutor in Practical classes	1	2	3	4
Assignments	1	2	3	4
Opportunity to undertake re-tests	1	2	3	4
Worked solutions for in-class tests, midterms & exams	1	2	3	4
PASS tutorials	1	2	3	4
Group project	1	2	3	4
Other work done in your own time	1	2	3	4

Given the interest in this thesis on eLearning site the survey also examines whether the subject, the main eLearning page and the structure of the subject eLearning site could be improved so as to create better conditions for students' understanding and learning (refer, Table 3.11).

Table 3.11 The usefulness of eLearning

How useful are the existing online resources in helping you understand in this subject?	Did not know they are available	Did not use	Rarely used	Little use	Moderately useful	Extremely useful
eLearning home page	1	2	3	4	5	6
Worked examples	1	2	3	4	5	6
Tutorial solutions	1	2	3	4	5	6
Assignment solutions	1	2	3	4	5	6
Self- tests	1	2	3	4	5	6
Sample test papers	1	2	3	4	5	6
Other additional resources	1	2	3	4	5	6
Forum eLearning page	1	2	3	4	5	6
Summertime Math	1	2	3	4	5	6

Finally, several open-ended questions were asked relating to students' perceived *next steps* or best ways to further improve MATH151 along with more specific questions about aspects of the eLearning site and assessment:

- How best can MATH151 be improved?
- If you can imagine a better structure for to the subject (lectures, tutorials, completing modules etc) that would help you to learn more effectively or efficiently, please describe briefly below.
- Is there anything done differently in your other subjects that could be used in this subject to make it easy to learn?
- If there were one thing you would like to see improved in the design and delivery of this subject, what would it be?
- Do you have suggestions on ways to help you to use the eLearning site to improve your learning in this subject?
- How does the design of the eLearning page compare to other subjects you have seen on eLearning?
- Is there a better way of setting the assessment that would motivate you to learn more?

The *Change Evaluation Survey* was consistent throughout the three implementations with the exception that in the second and third surveys additional questions were added in response to the changes in assessment and resources provided to students. These included items about the usefulness of the group project and the orientation videos. In these surveys students were also asked what they gained from the design of the eLearning site and learning design map (refer, Table 3.12).

Table 3.12 Student gain from design

What did you gain from the design of eLearning and the learning design map?	Strongly disagree	Disagree	Moderate	Agree	Strongly agree
▪ The connection between tasks and resources	1	2	3	4	5
▪ The organization of work and learning materials	1	2	3	4	5
▪ Found support available	1	2	3	4	5
▪ Clear understanding of what you have to do and what resources you have to help you to do tasks	1	2	3	4	5
▪ The connection between tasks and resources	1	2	3	4	5
▪ The organization of work and learning materials	1	2	3	4	5
▪ Found support available	1	2	3	4	5
▪ Clear understanding of what you have to do and what resources you have to help you to do tasks	1	2	3	4	5

In terms of the validity or trustworthiness of the Change Evaluation survey several forms of triangulation were undertaken as listed in Table 3.13.

Table 3.13 Validation procedures Case Study1

Tool	To increase the validity of the instruments and interpretations
Change Evaluation. Used to gather students' experience of the subject resources, including the eLearning site and perceived learning outcomes.	• Data triangulation, involved using different sources of information to validate the process. The Change Evaluation process ad survey had been formukated, modified and used with lecturers on eleven subjects (Porter, 2007). Previous examples of use of the Change Evaluation Process (Porter, 2007 & Baharun, 2013) suggested that instrument it could predict changes in appropriate directions after the introduction of innovations. Three cohorts of students were asked to complete the Change Evaluation. • Investigator triangulation. Lecturer, PhD student and supervisor each reflected and commented on results in this thesis. • Methodological triangulation. This involved the discussion with the subject lecturer and a survey of students. The listing of resources was confirmed by the lecturer as key resources and added to as appropriate for the subject. Issues of interest identified by the lecturer and inclusion in the Change Evaluation given to students for comments and they were asked for additional issues, thus verifying the appropriateness of scope for the instrument and process. • Environmental triangulation. This involves the use of different students in different time in each section

3.2.3 Redesign of the eLearning site

The focus of the study was the redesign of the eLearning site. This undertaking involved the exploration and adoption of an approach to learning design, the use of tools such as concept maps to highlight features of the learning designs, the creation of videos to provide learning support for student, and this in turn involved a suite of tools for the video creation.

3.2.3.1 Exploration of learning designs

The development of effective online learning environments that meet pedagogical needs requires the application of appropriate instructional design principles (Siragusa

et al., 2007). In order to improve learning experiences and learning outcomes, lecturers need to understand how learning designs can best deliver the learning support students need and how to make effective use of the available resources to improve student learning.

The first step in the exploration of the learning design involved an investigation of current approaches to learning design, particularly on approaches focusing on on-line learning (refer Section 2.4). The next step was to examine the existing artifacts in conjunction with the Learning Design Visual Sequence (Agostinho, 2009) design as a template to identify ways to effectively combine resources for students, such that the design clearly indicated what is happening in the subject, what resources and supports are available and how these are aligned with the tasks that they are to complete. In this way the design not only becomes a resource to allow students to undertake their learning activities but also guides them through the process. Online communication tools provide opportunities to support the learner and allow lecturers to facilitate learning (Brack et al, 2005).

Associated with this reorganization of the way in which online resources are made available for students is the identification of what additional resources are required and how they should be located and for this concept mapping was frequently used. The redesign also required an awareness of the capability of technology tools both in terms of the hosting and creation of resources.

3.2.3.2 Concept maps

Concept maps are a graphic representation of a person's structural knowledge or conceptual understanding of a topic (Novak & Gowin, 1984). They show "*concepts, usually enclosed in circles or boxes of some type, and relationships between concepts indicated by a connecting line linking two concepts*" (Novak & Caas, 2006, p1). When made by students, concept maps summarize understandings acquired after the completion of a unit or chapter (Novak & Caas, 2006).

On an eLearning site, a concept map may represent the lecturer's perspective of the subject. For example Figure 3.4 show concept maps linking the concepts to be covered used in the development of orientation and theory refresher/overview videos. The lecturer discussed the links between the concepts in the video clip.

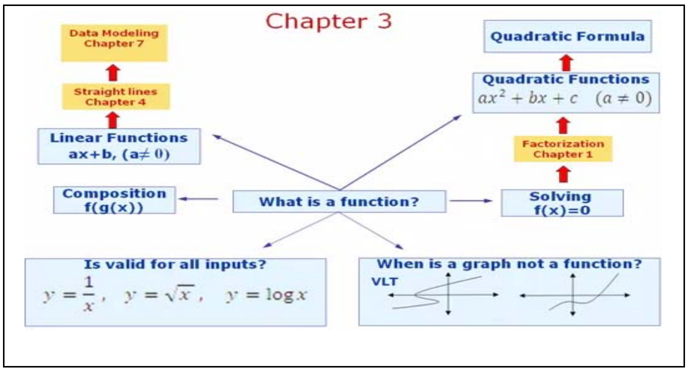


Figure 3.4 Nelson and Bukhatwa, Theory overview
Source: Australian collection, Content without Borders http://oer.equella.com/

When a concept map is embedded into the eLearning system, it is possible to identify where to add an extra layer of resources into the concept map. Each idea on the concept map can have associated with it a video exploring or demonstrating the relevant idea or technique.

3.2.3.3 Video creation

A key component of the redesign of eLearning site involved the creation of video resources so students can watch and re-watch if necessary. The resources required were identified, in some cases created and combined following the examination and use of learning designs that focused attention on resources, activities and supports. Before making any such resources the question of how they are to be made available to students was considered, this often involved satisfying technical requirements. The videos created have typically been less than five minutes long with small file sizes (less than 6Mb) for ease of downloading/playing.

The production of video resources involved a number of steps from creating electronic documents (Microsoft PowerPoint, Microsoft Word, Windows Journal, PDF) and annotating these using PDF Annotator while recording screen images, movement and audio. The final editing involves producing Shockwave files for FlashPlayer videos using Camtasia Studio. The production of video resources was undertaken using of tablet technology tools. In terms of the use of video resources as learning support, different designs of videos can potentially have different impacts on student learning. For example, Algarni (2009) theorised that videos for hearing impaired students that include four texts (audio, printed, written and caption) might result in a higher cognitive load for students and hence not be as effective for learning compared to two texts (audio and caption only). Several different genres of

video, in particular demonstrations, and orientation videos, were created or made available to students as learning resources.

3.2.3.4 Technology tools for producing videos resources

The initial video capture work at UOW used a camera crew to record a teacher solving problems on the whiteboard (Aminifar, 2007). This method was expensive and led to the idea of using screen capture on a Tablet PC. Software packages that complemented the use of the Tablet PC and Camtasia Studio which were used in this production of videos during this thesis include:

- PowerPoint, Word, Beamer. The content, usually in the form of slides, is developed in an application such as PowerPoint, MS Word or Beamer. The content may take the form of a problem followed by a pause for either handwriting or building the solution through a sequence of steps. The video production process involves converting these slides to pdf for further modification or annotation. Camtasia Studio provides an option for recording directly from Microsoft Office PowerPoint 2003 or PowerPoint 2007.
- pdf Annotator. This is the preferred package. It has a wide selection of pens, highlighters, typefaces, colours, rubbers and other features that are useful in video production. Camtasia Studio can both record voice and annotations or highlights made using pdf Annotator.
- Video capture**.** Camtasia Studio has several desirable features for the creation of videos. It is possible to record a selected region of the screen, a specific window, the entire screen, or a PowerPoint presentation and record what is visible. This enable input recordings from the screen, or a web camera and audio from a microphone; import several media formats in unedited form. The editing interface is user friendly and provides many options for editing the clips a timeline such as adding and deleting, highlights, sound, and transitions (Clark and Kou, 2008) (refer, Figure 3.5).

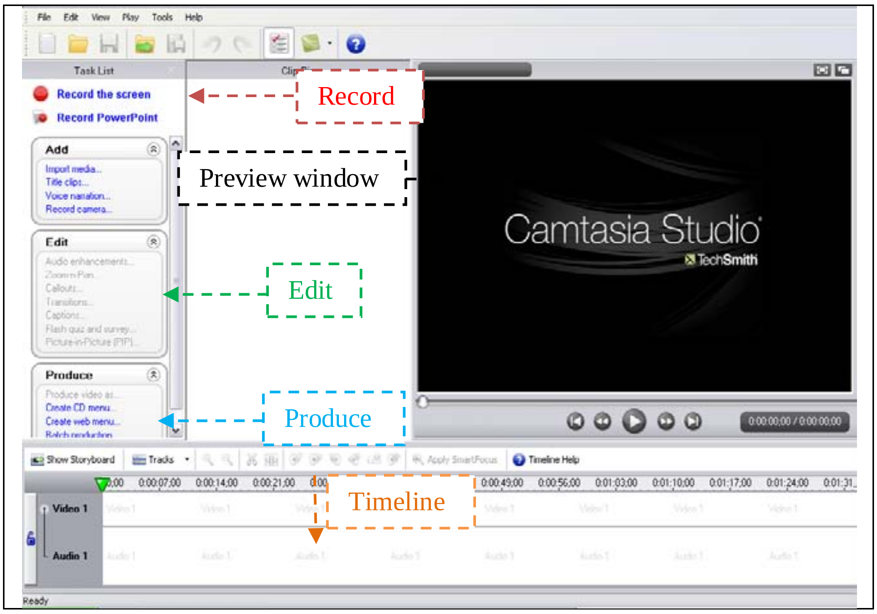


Figure 3.5 Camtasia Studio Interface version 6

3.2.4 Cycles of evaluation, redesign and implementation

The first case study involved the researcher working in an Australian context with a lecturer to improve outcomes in a subject taught through blending traditional lectures and tutorials with online delivery. The key cycles in this cases study were those framed by the teaching cycle. The participants in this case study are typically first year undergraduate science students. The subject is taught in the first session of study each year. The process for improvement has, through reflection on the various sources of data, drawn on the perceptions of the lecturer, identified in *Next Steps*, and students, gathered through a baseline *Change Evaluation Survey*, followed by a redesign of eLearning. The focus of ensuring the redesign was on developing an improved way to combine resources so that students could better visualise and understand the learning process.

The sequencing of the collection of data for the baseline and two implementation phases each involving a re-design is illustrated in Figure 3.6.

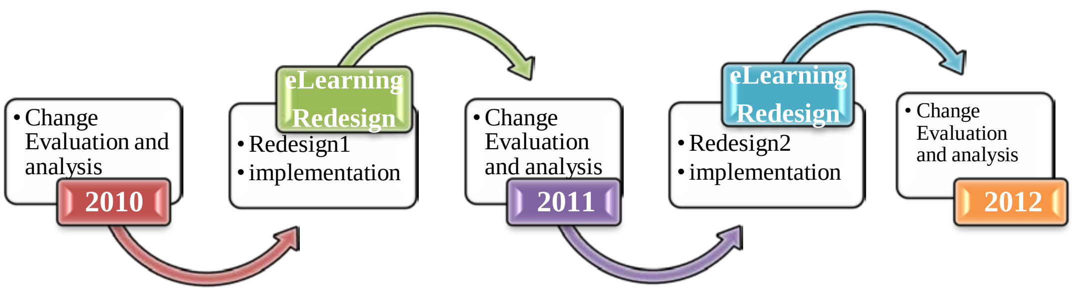


Figure 3.6 Sequencing of data gathering redesign and innovations

The first evaluation of this subject, in the baseline phase, allowed the usefulness of the learning resources to be investigated and the identification of potential strategies for improving resources. That is the baseline helps identify strategies to develop to enable students to learn more efficiently and hence to give them a better opportunity to successfully complete the subject. The second and third *Change Evaluation Surveys* examined the impact of the strategies developed in the first and second redesign of eLearning site respectively.

3.3 Case study 2: Professional development for technology in mathematics education

From the second case study the ease in which different technologies could be learned was ascertained in the Australian context together with the use of technology in the subjects taught. It was intended that this case study elucidate the possibilities for teaching with technology in a developing Middle Eastern country. The case study also involved the investigation of methods of staff development from different perspectives: the literature, staff learners' perspectives, postgraduate students' perspectives, and, from the professional developers' perspectives.

3.3.1 Purpose

The broad aim of this case study, *Technologies in Higher Mathematics Education,* is to identify what and how technology is used in mathematics teaching and research at an Australian University. Associated with this, it aims to identify good practice in the use of technology in mathematics. The intent is to capitalize on lessons learned through educational developments that have been tried and tested in an institution recognized for its quality in teaching and research in order to deliver an advanced starting position for staff and students in developing Middle Eastern nations who are beginning their exploration of what is possible with technology in mathematics teaching and learning. The validity of this approach in terms of transferability to the Libyan/Omani cultures is addressed in Section 7.3.1. The aims extend to identifying professional development strategies used or needed in this Western institution, as these may be needed by mathematics educators in Middle Eastern countries to introduce new technologies into the teaching and learning of mathematics. More specifically the aims are:

1. To identify teaching and learning technologies in use in an Australian mathematics department known for its quality teaching.
2. To identify open source, freely available equivalent technologies comparable to those used in Australian universities that can be used in Middle Eastern countries
3. To identify how and why staff and postgraduate students used the technologies and the difficulties associated with learning them in terms of self-development and staff development.
4. To identify approaches to staff development that may be useful for delivery of a professional development program in the Middle East.

3.3.2 Research design

The research design drew heavily on the need to triangulate in order to obtain trustworthy perspectives as to the nature of and needs in relation to staff development. Hence the design involved:

- Methodological triangulation. This involved the use of multiple qualitative and/or quantitative methods, namely artefact analysis (documents), interviews, and survey analysis.
- Data triangulation, using different sources of information, different participants, postgraduate students, academic staff and general staff, was used to ascertain their use of technology and needs for professional development.
- Investigator triangulation. Lecturer, PhD student and supervisor each reflected and commented on results. As the focus in this study was on the 'experience', several participants were asked to comment on conclusions drawn and data reported. Participants were asked to comment on the relevance and applicability of the results and to provide new or contradictory information

The initial examination of the artifacts available provided insight into what technologies were used and the scope of their use across subjects. This analysis was followed by the preparation of a survey for postgraduate students to identify uses of technology. This survey together with an interview schedule for academic staff regarding use of technology and needs for professional development, and an interview schedule for staff developers were used to examine techniques of staff

development. The analysis of this data was used to select topics for the development of a professional development package for staff in the Middle East in Case Study 3, *Professional Development in the Middle East* (refer, Figure 3.7).

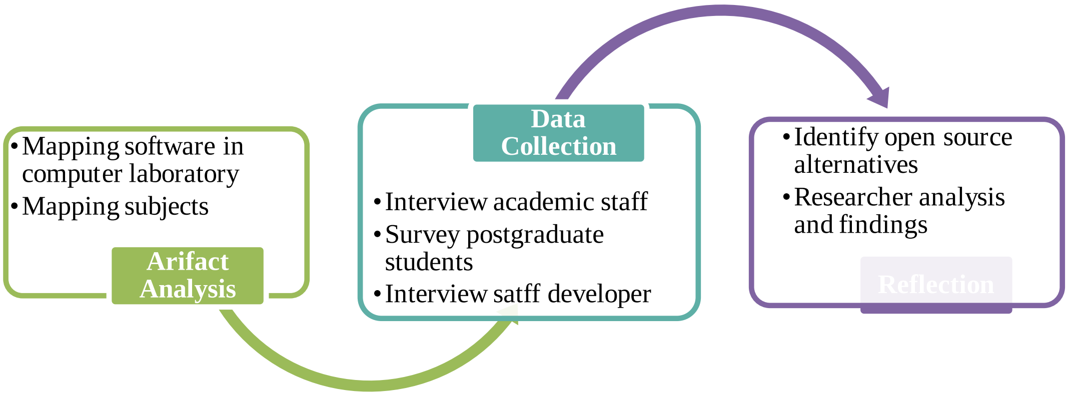


Figure 3.7 Research design case study 2

3.3.2.1 Artifact analysis

In the early stages of this thesis (2010) several artifacts were explored. This included the software in computer laboratories available in a mathematics computer laboratory at the SMAS at UOW, subject outlines, and subject listings in the University handbook on the University website.

- Mapping software in Computer Laboratories. The researcher examined the computer listing of software through accessing the SMAS computer laboratory, providing an alternative approach to identifying software used by staff and or students. All computers in the laboratory have the same software. Mapping this software provided a preliminary listing of software which could be used as probes in interviews held with staff and postgraduate students. The researcher, as a postgraduate, was also aware that postgraduate students each had their own computer and could request to have any program installed on their computer. Furthermore, these students have access to computers through other campus locations.
- Subject Mapping. These mappings were essentially an initial scoping to identify what subjects were taught and by whom. SMAS offers a variety of undergraduate and advanced degrees in mathematical sciences, including pure and applied mathematics and applied statistics. To identify subjects and associated software use, the subject handbook, subject outlines, and the University website for each mathematics subject were examined. The mapping allowed the alignment of subjects in the two countries (Libya and

Australia) in terms of desired outcomes/topics. It also identified the technologies and their functionalities.

3.3.2.2 Data collection interviews and surveys

Three data collections were made:

- A survey of mathematics doctoral students was undertaken to determine the technology and functionality of software packages that they used and how they used this software.
- Interviews of academic staff were conducted to identify desired learning outcomes, the topics taught and how technologies are used. While the emphasis was on teaching, in particular the use of technology in teaching and learning at each year level, it also included an investigation of research and administrative uses of technology and lecturers' needs in terms of professional or self-development to use such technologies. At these interviews, artifacts, screen shots, support materials and video resources demonstrating technology use were collected to allow documentation of technology use.
- Interviews of professional staff developers at UOW were used to identify professional development strategies used or needed when working with academic staff.

3.3.2.3 Reflection.

Reflection, on the mapping and data collection regarding technologies and their use in the Australian context, allowed the identification of technologies with functions likely to be useful additions to the Middle Eastern educational environment.

3.3.3 Ethical consideration

Ethics approval from the University of *Wollongong's Human Research Ethics Committee* (HREC) to collect data was obtained. Staff and postgraduate students were informed about the purpose of the study through a *Participant Information Sheet*, informing participants as to the nature of the study (refer, Appendix 2). Staff developers and postgraduate students also received the same *Participant Information Sheet*.

Participants (academic staff and staff developers) who were involved in the semi-

structured interview process were required to sign a consent form (refer, Appendix 3) as a part of the ethics process. This allowed the use of information gathered to be included in this thesis and/or publications, with the understanding that identities remain confidential.

3.3.4 Data collection tools

Three data collection tools were used in the second case study to complement the researcher's analysis of artifacts. These were tools included a survey for doctoral students and an extended version of this survey in the form of a semi-structured interview for mathematics academic staff. The third tool for data collection involved semi-structured interviews of staff developers at UOW used to assess strategies for and approaches to professional development. The focus of these data collection tools was to identify resources and technologies are that used to teach and research in mathematics, to identify how they are used and why these are used. The final focus was to identify how similar objectives may be achieved in other ways, with a view to determining what might be appropriate for use in Middle Eastern countries.

3.3.4.1 Postgraduate Student Survey

The purpose of this survey was to discover the technology and functionality of software packages used by students and how that software was used. Its development was based on both the artifact analysis and the literature review. It was designed so that postgraduate students could complete the paper-based survey returning it to the researcher either through her departmental mail-box or in person. The survey form was supplied along with the *Participant Information Sheet*. The first part of the survey involved basic open-ended questions (refer, Table 3.14).

Table 3.14 Open ended questions for postgraduates

- Are you an International or Domestic student?
- How has student use of technology changed in recent year?
- What Software packages do you use in graduate studies?
  How did you learn to use them?

The second part probed students as to their use of the different software packages that are supported by UOW and available either at the SMAS computer laboratory or in their desktop computer (refer, Table 3.15).

Table 3.15 Functionality of Software packages

Functionality of Software packages	Software packages	Use in research		How do you use it in research?	If you know please specify freeware/open source alternatives
		Yes	No		
Maths typesetting	LaTeX				
	MikTex				
	Mathtype				
Maths packages	Maple				
	Mathlab				
	Magma				
Statistical packages	SAS				
	SPSS				
	JMP				
	S				
	R				
	Ghostgum				
	Scilab				
	ML Win				
	STATA				
Microsoft Office	Word				
	Excel				
	PowerPoint				
	Publisher				
Spreadsheet					
Presentation Software	PowerPoint				
	Beamer				
pdf creator					
Majinea draw					
Camtasia[Video]					
Parallets desktop					
Bibliographic database	Endnote				
Others					

3.3.4.2 Academic staff interviews

The postgraduate student survey formed the basis of the first part of a semi-structured interview with academic staff. The purpose of this section of the interview was to gain from academics their experience in using software, as both a researcher and as a teacher. The emphasis was on teaching and in particular the use of technology in teaching and learning at each year level. As the functionality of the technology was explored academic staff were asked: 1) to identify what professional development they needed to attain the required skills to use mathematical or statistical packages; 2) how they used the technology in research and teaching; and 3) if they knew of specific freeware/open source alternatives.

The second part of the interview extended beyond the postgraduates' survey to ask about software tools used by the academic. The questions were developed following the artifact analysis of e-Learning websites, the literature review and the in situ identification by staff of the software that they used and why they used it (refer, Table 3.16).

Table 3.16 Questions regarding use of software tools

1. Do you use an eLearning space for your subject/ teaching and for student learning? Why?
2. How do you use eLearning? (e.g. Resource upload (subject outline, lecture/tut/lab notes), quizzes, assignment drop box)?
3. Do you feel comfortable using the current eLearning Space? Why (good/bad experience)? Explain.
4. What tools do you currently use (e.g. journal, forum, quiz (assessment), assignment (drop box) etc)? Why?

There were also questions about the function of eLearning site such as “How do you use software tools within eLearning, “what features are used in your teaching”, “how did the features help you to improve learning or your ability to manage your class activities” “For each of the online features used in your teaching, how did the features help you to improve learning or your ability to manage your class activities?” These prompts were used when staff indicated that they used particular software. Academics were asked if they needed professional development for each of the features listed in Table 3.17 with regard to whether or not they used or did not use the feature and sought further clarification whether it was not used, don’t wish to use or don’t know about it.

Table 3.17 Questions regarding how software tools were used

For each of online features used in your teaching, how did the features help you to improve learning or your ability to manage your class activities?

1. Give learners access to e-readings (Online readings and links available via library)
2. Make available video / audio resources
3. Make available support resources for learners (e.g. lecture notes / tutorial resources, labs)
4. Embedded web links for learners
5. Hold online exams and quizzes
6. Have learners submit assignments online (via assignment drop box)
7. Provide assessment feedback
8. Track student performance, grades, activity and learning materials usage statistics (via grade book), tracking in terms of student use of files
9. Communication with learners (via forum, discussion announcement)
10. Get feedback from students (via forum, discussion announcement)
11. Selective release (group/ dates) e.g. an assessment can be released on particular day & time and then disappear at some other time

In terms of identifying useful technologies it was also thought appropriate to determine if eLearning site had impacted on teaching with questions posed such as those in Table 3.18.

Table 3.18 Questions regarding the impact of eLearning site on teaching

Did eLearning….

1. Save time or caused you to increase the time spent
2. Provide convenience
3. Help to manage and plan activities for students
4. Help to better communicate with colleagues
5. Help to better communicate with students
6. Create options for providing a flexible learning environment with access to multiple types of resources
7. Give a place for your audio visual elements

3.3.4.3 Staff developer interviews

Semi-structured interviews were held with staff developers which, with permission, were digitally recorded to allow more information gathering and discussion. The first set of questions ascertained demographic features of the interviewees, allowing the researcher to determine the sectors in which the developers worked. Questions addressing these areas were open ended, (refer, Table 3.19) and used to give the researcher opportunities to investigate views and opinions of the interviewee (Kajornboon, 2005).

Table 3.19 Demographic questions for staff developers

1. What is your current position / job title? What is your department or faculty or unit?
2. How long have you been in your position/ are you fulltime or part time?
3. How did you gain the experience necessary be a professional developer of staff?
4. Do you provide professional development activities/ seminars? If so what and how do you provide these services?
5. In what area do you undertake your staff development?

The second set of questions related to ascertaining how staff developers at UOW deliver professional development to academic staff, their aims, strategies and theories or experiences that informed their practices (refer, Table 3.20).

Table 3.20 Questions regarding aims, and strategies and their underpinnings

6. What outcome are you aiming for with your professional development strategy?
7. Is there a current theory or theories that inform you in conducting the staff development process?
8. What are the strategies or approaches you use when undertaking staff development at the university campus or satellite campuses?
9. What are the main components / strategies in your professional development plan?
10. Are some of these strategies more effective than others?
11. Are the strategies you use effective for working with mathematics staff or are there any special issues with people working in this discipline?
12. What literature informs your practice as a staff developer

The final set of questions examined issues that confronted or potentially confronted the staff developers (refer, Table 3.21).

Table 3.21 Issues confronting staff developers

13. Are there particular issues or strategies associated with introducing new technologies? How is that best done? How does one do this in a way that the technology becomes embedded in the university culture?
14. Are there any issues facing you as a staff developers such as
    - Sustainability of achievements/programs in adaption of new technologies
    - Engagement of staff in programs
    - Change of practices associated with the adoption of new technologies
    - Cultural issues
15. Are there any issues you have encountered working with different cultural groups?
16. Do you have any advice for someone about to embark on professional development of others?
17. Have you worked in this capacity in a developing nation? What sort of experience did you have?

3.3.5 Sample selection

The first step is to identify the population to be studied. Whittemore and Melkus (2008) argues that,

> *sampling plans for qualitative research are based on identifying specific groups of people who either possess characteristics or live in circumstances relevant to the social phenomenon to be studied Sample sizes are typically small and are based on the principle of data redundancy or saturation (p. 209).*

UOW was chosen as an institution for the first case study based on to its strong international reputation for quality research and education (World Ranking Guide, 2013). In this case study three samples were chosen within the institution reflecting the three populations of interest, namely:

1. Postgraduate students at the School of Mathematics and Applied Statistics (SMAS). The students were chosen from a list of students enrolled that had desk facilities within offices in the school or were on campus and located by the researcher. Of 53 PhD students enrolled all students who could be located (n=33), between April and August, were asked to participate (2011). All 33 students agreed to participate.
2. Mathematics academic staff. Forty-one mathematics academic staff involved in teaching and/or research were identified through the UOW website. The researcher asked each member of staff not on leave between the dates April to November (2011) to participate. Those who agreed to a face-to-face interview were chosen and resulted in 28 staff being interviewed.
3. Staff whose role is to develop staff. Not all staff were in positions described as staff developers, hence the total population of UOW staff engaging in such work was not known. Twenty-four staff members engaging in professional development were identified through a snowball referral technique. No staff member contacte refused to be interviewed. The initial starting point was

obtained from the supervisor of this project who identified possible developers and the sections within which they worked. The website provided other potential names. The interviewees also provided the names of further people who were engaged in staff development. The researcher sent an introductory email to the chosen staff developers to make an appointment (refer, Appendix 4).

3.3.6 Analysis

Artifact, survey and interview data were used to generate information regarding which technologies were used, how they are used and what lecturers and students gained from their use. The intent was to make available these technologies, or their equivalent, for staff in developing Middle Eastern countries. Using UOW staff experiences as to what professional development was required and how it was delivered.

In Case Study 3, *Professional Development in the Middle East,* a professional development package was developed, implemented and evaluated in Oman. This has led to recommendations regarding professional development in the Middle East

3.4 Case study 3: Professional Development in the Middle East

In this case study the staff in one Middle Eastern country were provided with professional development in the use of software and hardware that can be used to support and improve teaching and learning in mathematics. The researcher in the first two case studies, *Redesign of eLearning site* and *Professional development for technology in mathematics education,* had identified professional development as an issue that needed to be addressed if the provision of better tools for mathematics education and the effective use of these tools were to be acquired by staff in developing Middle Eastern countries.

The third case study involved identification of a site in the Middle East for the trial of the staff development program and its development, implementation and evaluation. Adopting suggestions from the literature and from interviews with professional developers, the model for professional development could be described involving training aspects, follow-up support, focus on tools and the needs in technology training and need to know about technology tools to change classroom

practices. The basis of the staff development program was seminar/workshops which were designed to introduce staff to learning designs, tablet technology, video resource creation and construction of html web pages. Follow-up support was provided. These seminars were followed by an investigation of staff interests in further professional development allowing them to be initiated into whatever technology they desired. This was the start of their professional development process. Issues arising that pertain to staff development in developing countries were identified and addressed to provide a model for sustainable staff development in these countries.

3.4.1 Purpose

The broad aims of this study were to raise awareness of the importance of technology for improving students' learning outcomes and to create a broader culture of technology use in one Middle Eastern country so as to facilitate the development of a supportive community of practice. More specifically the aims were as follows.

1. Engage staff in a Middle Eastern country with a view to trialling a professional development program designed to introduce current approaches, as identified in the Australian context, to using technology their classrooms.
2. The program was to provide information to participants regarding resources and technologies that can be used to improve mathematics learning outcomes. It was also to teach tools and show how to integrate technology with good pedagogical practice. Further, it was to introduce staff to Tablet PC technology and the use of the tablet in lectures and the creation of learning resources.
3. Evaluate and suggest further refinement for the professional development program.

3.4.2 Research design

Taking advantage of what has been learned elsewhere is important if the education gap between developing and developed nations is to be closed. The first case study was used to identify good learning practices and the technologies used in one mathematics subject. The second case study, at UOW was used to identify the broader mix of current technologies and uses of technologies in mathematics and through this to identify topics suitable for inclusion in staff development in two

Middle Eastern countries. The third case study commenced with an examination of the context and challenges of teaching in Libya and subsequently Oman (refer, Figure 3.8.). There were many differences between the Australian context and that of the Middle East (refer Section 7.3.1), and it was not known whether the professional development package created as a part of Case Study 3 to introduce technologies into Libyan mathematics education would be successful or whether it could be readily transferred to other contexts such as Oman and Malaysia.

To ensure that trustworthy data regarding the impact and appropriateness of the professional development program, a variety of data were collected using data (students and staff), methodological (artifacts, surveys and interviews), investigator (researcher, participant feedback on reports and supervisor) and environmental triangulation (Oman & Malaysia).

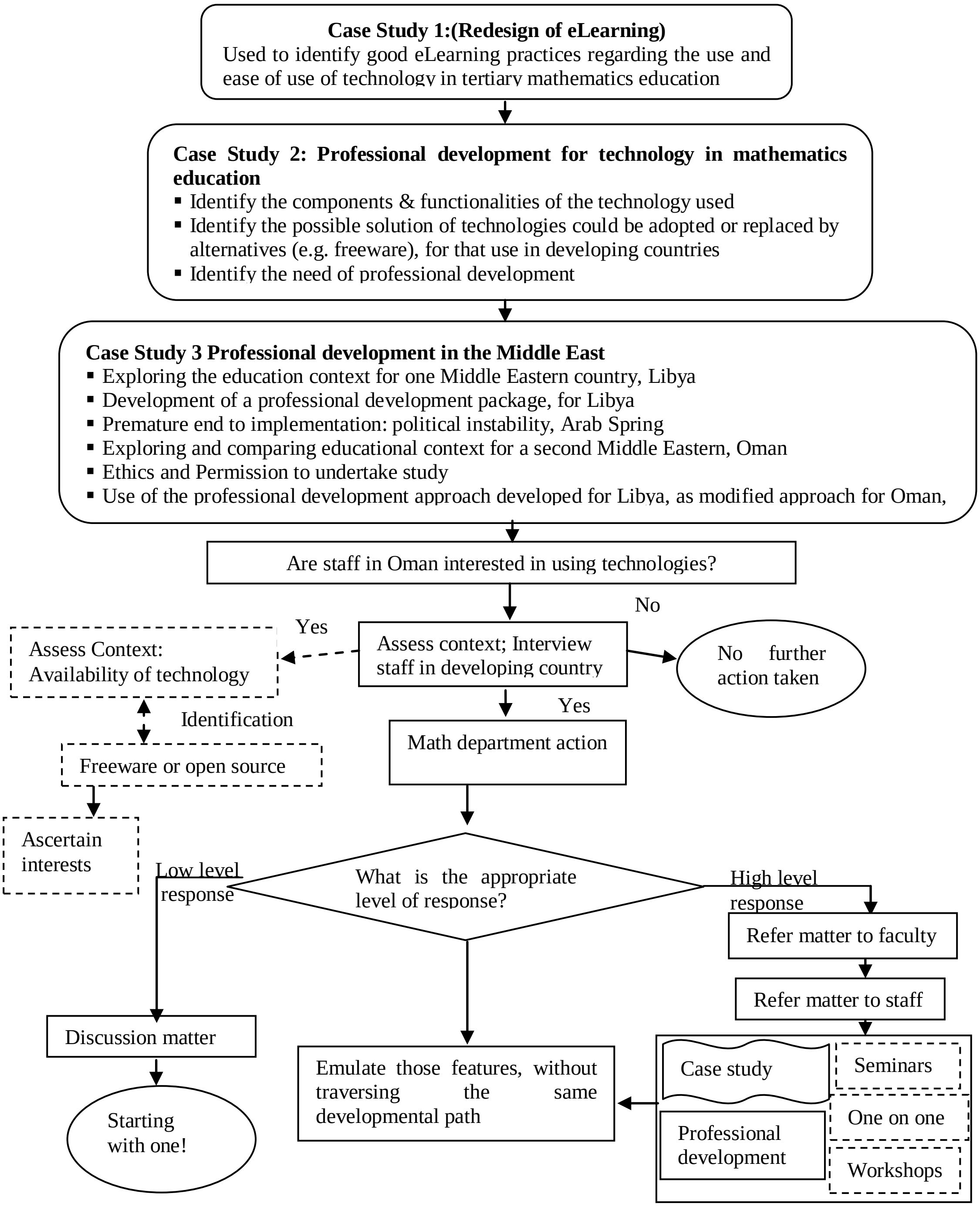


Figure 3.8 Design: Integration of three case studies

The methods undertaken in the final case study involved three stages preparation, collection of data through surveys and reflection upon findings (refer, Figure 3.9).

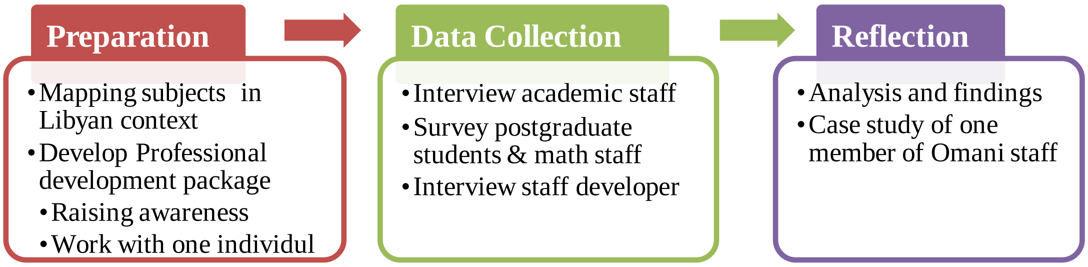


Figure 3.9 Research design - Case Study 3

3.4.2.1 Preparation: Artifact analysis

Artifact analysis in this case study involved the mapping of subjects. Translating from Arabic to English the researcher used the university website (http://www.uob.edu.ly/science_faculty/math_courses.aspx) to provide the details of requirements for a Libyan Bachelor of Science degree (B.Sc) and the description of B.Sc course at the Department of Mathematics at the University of Benghazi (Garyounis). This allowed a comparison of the subjects taught in UOW and the University of Benghazi. Mapping the subjects allowed the alignment of subjects in the two universities in terms of desired outcomes/topics. This allowed the opportunities available to introduce technology to Middle Eastern Libyan staff to be identified. This, together with outcomes from the first two case studies, provided suitable topics for a professional development program to be developed for the introduction to technology with a focus what can be more fully exploited in Middle Eastern contexts such as Libya.

3.4.2.2 Preparation: Professional Development Package

The planning of the package was made after an investigation of the Libyan context, but before the Arab Spring conflict. With the Arab spring confluict commencing the researcher sought to find a place, which was more stable and safer than Libya, and Oman was identified as one such a Middle Eastern country. The Omani educational context was then compared with the Libyan context in terms of culture, economy, language, religion, education system and teaching methods. Comparisons were also made of available technologies (networking, Internet, wireless and various software), professional development and the use of eLearning (refer sections 7.3.1). After this examination it was considered that the package planned for Libya would be appropriate for delivery in Oman, however the appropriateness of this assumption was to be tested through evaluation outcomes from the professional development

designed to raise awareness of new technology for inclusion in teaching in the mathematics discipline.

The first part of the professional development program, *Raising Awareness,* introduced staff to a blend of tools and a pedagogy base so as to raise the awareness of Omani staff, both mathematics and professional developer staff. The second part was to work closely with an individual member of staff, to help them introduce teaching tools into their subject. Evaluation followed both raising awareness workshops and the introduction of technology to one teacher's classroom (refer, Table 3.22).

Table 3.22 Workshops process

Aims	1. To make staff aware of the significance of technology for student learning outcomes 2. To initiate the development of skills and approaches for the use of technology in mathematics teaching and learning at SQU 3. To identify a lead innovator, with the intent of preparing that participant for the trial integration of technology into their teaching with a follow-up assessment of the impact on student learning outcomes
Preparation	The preparation followed the identification of the technology used and associated professional development undertaken at UOW (refer, Chapter 5) and an identification in this case study of the technology used by SQU mathematics staff and of the difficulties faced by staff in using technology. In this manner the program for Libyan staff was adapted, but the introduction of SQU staff to new technologies was situated within the SQU context.
Content	The training session and hands-on practice covered four topics. 1. Using a Tablet PC in lectures, a. Introduction to touch-screen tablets; b. Inking (writing) in different software packages such as PowerPoint, Microsoft Word, PDF annotator, Windows Journal and Sticky Notes. 2. Resource generation The introduction to resource creation involved using the Tablet PC and Camtasia Studio software to create video resources. Subtopics included: a. Introduction to different video genres b. How to record with Camtasia Studio. c. How to edit projects, including features such as zoom-n-pan, split, cut unwanted video and audio on the timeline, add transitions, add a title clips, audio enhancements, save and produce in a variety of formats. 3. Learning design approaches and three examples for the combination of learning resources used in several subjects at UOW and show of Summertime Math DVD as a web-based learning resource 4. Evidence based evaluation to guide change Two examples of evidence based evaluation to guide change.
Material needed	1. Laptop, projector 2. Participants name signs on the table 3. Note books and pens for participants 4. Copies of the agenda for all participants 5. PowerPoint slides with Workshop objectives and copies of the agenda for all participants
Scheduling	1. Notification of the workshops by a flyer sent by email to mathematics staff 2. Multiple two hour workshops scheduled over a two month period, to accommodate staff in groups of up to eight sharing four computers 3. The timetabling of the staff development was based on staff choices, with groups formed based around staff availability
Target Audience	The training is intended for staff in mathematics department or those working in learning development. However, participation from other development areas should be strongly encouraged in order to raise their awareness of the importance of technology in student learning outcomes.
Certificate	The researcher provide a certificate from the UOW

Evaluation drew from the three evaluation models proposed in (Section 1.6). In accord with Alexander and Hedberg (1994) innovations need to be evaluated at all four stages design, development, implementation, and institutionalisation. In this case study the latter two phases were evaluated. The Parry and Berdie model was used to frame the evaluation of the implementation of the professional development. This evaluation required documentation be provided for future refinement (refer, Appendix 8-12 for workshop outlines) and feedback be gathered with respect to satisfaction, opinion (such as perceptions as to relevance), knowledge acquisition, knowledge comprehension, skill demonstration and skill transfer of the training. At the end of the workshop participants, in accordance with the Parry and Berdie model completed a training evaluation form developed to address their evaluation criteria (refer, Table 3.23). As suggested by the Kirkpatrick model evaluations were also used to identify changes and refinements to the staff development program.

Table 3.23 Training Evaluation Form

1. Was your interest held?
2. Did the course give you ideas about how to:
    a. Integrate the Tablet PC into the teaching process
    b. Produce video resources by using Camtasia software.
    c. Combine learning resources using Learning design
    d. Use Summertime Math DVD / or similar.
    e. Use Evidence based evaluation to guide change
3. Overall, how would you rate the course?
4. What things from this workshop do you think you would like to apply to your academic work?
5. What would you recommend changing about the training?
6. What additional training (if any) would be helpful?
7. Do you have any further comments, observations or suggestions

The last level of Parry and Berdie model skill transfer, focuses on evaluating the application by the trainee of new knowledge and skills, in this case in the classroom. Therefore a staff member was chosen to trial the teaching tools within one of their subjects. The transferability and embedding of

3.4.2.3 Ethical consideration

The collection of data in this study, involved review for ethics clearance from the UOW Human Research Ethics Committee (HREC), Australia, and from the Office of the Adviser for Academic Affairs at SQU, Oman. As for participants in the earlier case studies, lecturers and postgraduate students were informed of the purpose of the study through a *Participant Information Sheet* (refer, Appendix 2) and signed for case study 2, *a consent form* documenting their agreement for the interview to be recorded (refer, Appendix 3). Staff also gave permission for interview excerpts to be

included in this thesis and/or any publications to come from the research, with the understanding that quotations would be either confidential or attributed to them only with their review and approval.

3.4.2.4 Reflection

Reflection accompanied the observation from case study 1 & 2, mapping and data collection regarding technologies and their use in UOW. So it was possible to identify which technologies may be useful additions to the Middle Eastern educational environment. Identification of alternative technologies, in particular less costly ones such as freeware or open source could be made available came initially from the users interviewed and surveyed in case study 2 and this was supplemented by additional literature review.

3.4.2.5 Sample selection

Insight into issues in Libya together with identification of current western practices led to the second stage development, in this case development of a professional development package for staff in Libya.The Sultan Qaboos University (SQU), in the Sultanate of Oman (Oman), was chosen as the site for the trial of the professional development program (refer, Section 3.4.2.2). The detailed preparation in the design phase was for the Libyan context and while it cannot be assumed that the experiences and artifacts transfer across the nations, with similarities and contrasts identified, (refer, Section 2.2 & 7.3.1), it was considered that Oman was safe, accessible, and similar in many ways and therefore a suitable alternative to Libya. The design formulated for Libya, and tempered by considerations in relation to Oman was therefore considered appropriate.

Succcessful implementation of the professional development in Oman would speak to the appropriateness of needs assessment at the design phase, the success of the professional development implementation and to the idea of transferability of the professional development package to another context. Further evidence of transferability was gathered by the later opportunistic presentation of the professional development package in Malaysia (refer, Section 6.4)

In this case study three samples sets were chosen from within the SQU. These were chosen in the same way as for the corresponding sample sets in the second case study

in UOW. The three populations of interest are:

1. Postgraduate students at the Department of Mathematics and Statistic (DOMAS). During the months February to April (2012) the researcher approached students in their rooms to invite them to participate and to provide details about the study, both verbally and through the *Participant Information Sheet*. Ten students agreed to participate. The researcher left the survey in their rooms and returned to collect those that were completed.
2. Fifty-four mathematics academic staff at SQU were identified through the DOMAS website that lists the names of mathematics staff involved in teaching and/or research. These were all asked to participate in the *Raising Awareness Seminars* through an email invitation issued by the Head of the Department. The staff located those with free time between dates from February to April 2012 were asked to complete a survey on their use of technology which was distributed through the staff mailbox. The researcher also contacted staff by email, asking for suitable times for the interviews. As a consequence interviews with 29 mathematics staff out of a total of 54 were conducted
3. Staff developers were identified through a snowball referral technique. The total population of SQU staff engaging in staff development was not known as not all were in positions described as staff developers. An initial starting point was obtained from the researcher’s visit to the different centres related to staff development. This identified possible developers and sections within which they worked. The SQU websites provided names of others. The interviewees also provided the names of further people who were engaged in staff development and these names were followed up with a request for an interview and appropriate time for an interview.
4. One staff member was selected to trial the teaching tools within one of their subjects. This lecturer along with 35 students, were asked for their experiences with the use of Tablet PC technology over a one week trial period. Students were asked to complete a paper evaluation survey. Thirty one students responded to the request. The aim of the survey was to evaluate the effectiveness of the tablet technology and resources produced with it.
5. Two groups of staff and postgraduate students at UiTM (Perak, n approximately 50) and UiTM (Malaysia, n approximately 30) completed

workshops in Malaysia. This allowed an examination of the transferability of the workshops. Surveys were completed by 25 participants from UiTM (Perak) and 16 from UiTM (Malaysia).

3.4.2.6 Materials for contacting staff

Staff were invited to participate in a survey and an interview by an email sent by the Head of School (refer, Appendix 5). Staff were reminded of the invitation by the secretary to the Head of School and asked to nominate a workshop time (refer, Appendix 6).

The researcher provided a timetable (refer, Appendix 7).for the workshop. Staff then informed the researcher as to their willingness to attend along with a viable timetable. The researcher organized groups according to their availability and informed them through an email as to the time and location of the workshop (refer, Appendix 8). At the end of the workshop the participants were given a certificate of participation.

3.4.3 Data collection tools

Corresponding to several different aspects of the professional development program and its evaluation, several tools were used to collect data. These included:

1) A survey of academic mathematics staff to assess the impact of the *Raising of Awareness* workshop;
2) A survey of mathematics postgraduate students undertaken to determine the technology and functionality of software packages and how they used software;
3) Semi-structured interview questions for academic mathematics staff conducted to identify how technologies are used and lecturers' needs in terms of professional development to use such technologies;
4) Semi-structured interview questions for professional staff developers which identified professional development strategies used or needed when working with academic staff;
5) Evaluation/feedback of workshops; and,
6) Paper based evaluation survey of undergraduate.

These data collection methods provided a rich and diverse set of evidence

documenting the teaching and learning of mathematics in DOMAS.

3.4.3.1 Survey of DOMAS staff

The primary purpose of the survey instrument, *Survey of DOMAS Staff*, was the evaluation of which technology and software has been provided to students and how the technology was used. The survey was also used to identify which software and resources could be used in order to determine the staff's development opportunities.

The survey started with general demographic questions with respect to age, gender and staff classification, so that the group could be appropriately described and, where possible, differences between groups ascertained. These were followed by question about the use of technology (refer, Table 3.24).

Table 3.24 The use of technology

1. As a technology user, I classify myself as: Not yet , Beginner w/support, Confident on my own, Capable of teaching, Others
2. How often do you use the Internet at Home /work? 3. How often do you use the Internet for your teaching? 4. How often do you use the computers in teaching mathematics? Each with responses Daily Once or twice a week Once or twice a month Less than once a month
5. If you use the computers in teaching mathematics what do you use, what software, what objectives, what sort of success do you have, what sort of difficulties? 6. What subject areas do you currently teach?

Staff were questioned about uses of computers to establish their current skills and uses of computers (refer, Table 3.25).

Table 3.25 Staff current skills and uses of computers

Purpose	(1) Do Not use	(2) Occasional < 1 hr /week	(3) Moderate 2-5 hrs/ week	(4) Extensive > 5 hrs/week
1. Type letters and other documents				
2. Play computer games				
3. Create instructional material				
4. Administrative record keeping				
5. Student Grades, Students details,…				
6. Classroom presentations 7. PowerPoint/CDs/DVDs				
8. Databases				
9. Spreadsheets				
10. Word processors				
11. Other (Please state)				

Staff were also questioned about the reasons for uses of the Internet (refer, Table 3.26).

Table 3.26 Staff reasons for use of Internet

Purpose	Do Not Use	Occasional ≤1 hr/wk	Moderate 2-5 hrs/wk	Extensive > 5 hrs/ wk
1. Communicate with family/friends				
2. Communicate with other teachers				
3. Communicate with students on School related matters				
4. Search for information on topics of personal interest (e.g. Hobbies, etc.)				
5. Search for information and content for lessons				
6. Retrieve research & best practices for teaching/learning				
7. Purchase items online				
8. Retrieve Model Lesson Plans				
9. Administrative record keeping (student attendance, grades, etc.)				
10. Other (Please state)				

Questions were asked about methods of communication between both students and colleagues (refer, Table 3.27).

Table 3.27 Methods of communication

	Student	Colleague
1. In class	Yes/No	Yes/No
2. By e-mail	Yes/No	Yes/No
3. Facebook/similar	Yes/No	Yes/No
4. Skype/similar	Yes/No	Yes/No
5. Other	Yes/No	Yes/No

In accord with the “Next step” component of the evaluation questions were asked to identify the types of resources used by staff with a simply (yes / no) indicator (refer, Table 3.28).

Table 3.28 Types of resources used by staff

a) Text book	1
b) Subject outline	2
c) Films/video	3
d) Books	4
e) Internet	5
f) Lectures	6
g) Consultation with lecturer	7
h) Tutor in Practical classes	8
i) Assignments	9
j) Opportunity to undertake re-tests	10
k) Worked solutions for in-class tests, midterms and exams	11
l) Others ,explain what	12

Staff also asked questions to assess their computer and Internet experience (refer, Table 3.29).

Table 3.29 Staff rate of computer experience

Q1. How would you rate your computer experience?
Q2. How would you rate your Internet experience?
Both with responses
None
Little
Moderate experience
Experienced
Q3. What kind of software and hardware computer do you use?
Q4. How long have you used software and hardware with research / teaching? Why?

The staff was asked to select the most significant factor that was preventing them from using a computer or using a computer more frequently (refer, Table 3.30).

Table 3.30 Factor preventing staff from using a computer

1. I use a computer	1
2. No computer	2
3. No time	3
4. Not interested	4
5. Need training	5
6. No need	6
7. Nothing preventing me	7
8. Other specify	8

To assess staff needs in relation to professional development they were first asked if they felt able to integrate ICT into their teaching with responses “yes”, “no” and “I don’t know”. The support for the use of technology by their community was then examined as to whether it was “very important”, “important but not a priority”, “necessary, but do not like it”, “unnecessary”, “they do not think about the use of technology”, “Other”.

The remainder of the survey was about staff development, assessing the likely prospect of support in terms of new equipment. They were questioned as to the likelihood of receiving new equipment “Do you anticipate getting any new computers in the next 6 months? (“yes, definitely”, “yes likely”, “don’t know”, “probably not”, “definitely not”). In accordance to Parry and Berdie evaluation model (2004), to determine knowledge acquisition and knowledge comprehension, the next set of questions examined the desirability of development opportunities as they relate to helping staff use the computers software and hardware (refer, Table 3.31).

Table 3.31 Staff development questions

1. Strongly Agree, 2. Agree, 3. Neither Agree nor Disagree, 4. Strongly Disagree, 5. Disagree, 6. Not Applicable	
a) I would like to attend workshops which show how to integrate computers into the curriculum	
b) I would enrol in computer training classes designed to increase my knowledge on use of computers if my district would pay for it.	
c) I would attend conferences/seminars designed to increase my knowledge on use of computers if my district would pay for it.	
d) I would pay my own expenses to attend formal training activities designed to increase my knowledge on use of computers.	
e) Using a “trial and error” approach has increased my knowledge on use of computers.	
f) Periodicals/professional literature related to computer use has increased my knowledge on use of computers.	
g) Technical support in the use of computers from someone who could be considered an "expert” is beneficial for integrating the computer into my classroom practice.	
h) Observing colleagues to learn about computer integration strategies would be helpful for me so as to integrate computers into my classroom practice.	
i) Prompt technical assistance would facilitate my efforts to learn to integrate the computer into my classroom practice.	
j) Websites on the Internet about designing teaching strategies are helpful to me for integrating the computer into my classroom practice.	
k) I believe that mathematics is best learned without technology	

In accordance to Parry and Berdie evaluation model (2004), staff were also asked about their attitudes toward technology. For example, if they believed technology was an integral part of their teaching, what, if anything, did they need to make technology an integral part of their department (refer, Table 3.32).

Table 3.32 Staff attitudes toward technology

1. Strongly Agree, 2. Agree, 3. Neither Agree nor Disagree,4. Strongly Disagree,5. Disagree, 6. Not Applicable
a) Technology enhanced classrooms enhance your teaching
b) Technology could improve the efficiency of your performance in your research and teaching
c) Technology could improve the student learning mathematics
d) Technology could save time in dealing with students
e) Technology could enhance the effectiveness/efficiency of students learning mathematics in the university
f) Technology can increase understanding for mathematics
g) Technology could make learning more convenient
h) Technology could provide a number of alternative mediums for learning from which mathematics
i) Technology can provide learning experiences, opportunities, and tools that would otherwise be unavailable to them
j) Technology doesn’t help learning mathematics because ....

In accordance with the evaluation model of Alexander and Hedberg, whereby the design phase for innovation starts with an analysis of needs, staff were asked about their needs in terms of support necessary to use technology (refer, Table 3.33).

Table 3.33 Staff needs to use technology

1.Strongly Agree, 2. Agree, 3. Neither Agree nor Disagree, 4. Strongly Disagree, 5. Disagree, 6. Not Applicable	
a) I need more time to learn to use software with teaching mathematics	
b) I need more time to learn to use the Internet.	
c) I need more time to change the curriculum to better incorporate the technology.	
d) I need more training with technology.	
e) I need more examples in the use of technology in my content area.	
f) I need more training in strategies that integrate technology.	
g) I need access to more computers for my students.	
h) I need access to the Internet that is reliable.	
i) I need more current software that is curricular-based.	
j) I need prompt technical support to keep the computers working.	
k) I need more resources that illustrate how to integrate technology into the curriculum.	
l) I need to be able to try out technology-enhanced curriculum units in my classroom before I am comfortable with them.	
m) I need more opportunities to work with colleagues to become more proficient using technology-enhanced curriculum units.	
n) I need good reasons why I should incorporate technology into the classroom.	
o) A university technology plan, in which skills needing to be achieved are clearly spelled out, would help me to integrate technology.	
p) I need the administration to provide staff development activities in technology to persuade me to integrate technology.	
q) I need the administration to provide time for integrating technology into the classroom	
r) I need the administration to provide resources for integrating technology into the classroom.	
s) A district technology plan outlining steps for technology integration would help me to integrate technology.	
t) If I had enough computers in my classroom for each student, I would create more learning activities using the computer.	
u) I lack knowledge about ways to integrate ICT to enhance the curriculum,	
v) I find it difficult to integrate and use different ICT tools in a single lesson	
w) Students lack access the necessary classroom educational technology materials.	
x) I lack confidence with regards to integrating technology into the classroom.	
y) I lack personal access technology during lesson preparation	
z) Complete I need..in order to implement new/more technology in my classes	

3.4.3.2 Postgraduate student survey

The postgraduate students at DOMAS were surveyed to discover the technology and functionality of software packages they used. The survey is the same as that undertaken with PhD students at UOW (refer, Table 3.15 & 3.16).

3.4.3.3 Semi-structured interviews

Semi-structured interviews were conducted with two groups. Participants in both groups were provided with a participant information sheet and signed a consent form prior to the interview. The Alexander and Hedberg (1999) evaluation of innovation

model framed the study. The purpose of the questions for the first group, mathematics staff at SQU, was to ascertain the use of information technology in their department and thereby to determine their needs in relation to inclusion of computer-related technology in teaching and also how they used Moodle in their teaching and student learning (refer, Table 3.34).

Table 3.34 Semi-structured interview questions for mathematics staff

Q1. What is the greatest problem your math department has with its current information technology (computers or computer programs)?
Q2. What is your math department's greatest information technology need (including computers, computer programs, or other computer-related technology)?
Q3. What kind of computer training/specific topics would best benefit your mathematics department?
Q4. Some question about (Moodle)
Q5. How do you use Moodle? (E.g. Resource upload (subject outline, lecture/tut/lab notes), quizzes, assignment drop box)?
Q6. What and how did the online features that used help you to improve learning or your ability to manage your class activities?
Q7. Does Moodle a) Save time increase the time spent b)Convenience c) Help to manage and plan activities for students d) To better communicate with students e)Has created options for learning flexible environment with access to multiple types of resources

Interviews were completed both before and after the workshop. The aim of the interviews was to identify the specific needs and wants of staff and the difficulties associated with their current usage of technology so as to identify ways for them to integrate technology into their teaching. Their interviews sought details as to how they provided professional development (refer, Table 3.35).

Table 3.35 Semi-structured interview questions for staff at different centres

Q1. How did you gain the experience necessary to be a professional developer
Q2. Do you provide professional development seminars? If so what and how do you provide these services?
Q3. In what area do you undertake your staff development?
Q4. What outcome are you aiming for with your professional development strategy?
Q5. What are the strategies or approaches you use when undertaking staff development at the university campus / Are some of these strategies more effective than others?
Q6. Are there particular issues or strategies associated with introducing new technologies? How is that best done?
Q7. Are there any issues facing you as a staff developers

The interview was also used to identify a suitable member of staff to work with to provide a case study of an individual lecturer. The staff member selected had to show a willingness to develop resources and applications with the technology and also a willingness to further engage and help other staff in their use of the same. Thus it was hoped to seed the idea of maintaining professional development in this area. This member of staff was engaged in further one-on-one development, enabling them to use tablet technology to jointly create a variety of video resources which were embedded into a Moodle site for student use.

The second target group were professional developers from different centres at SQU. The interview was the same as that undertaken with the staff developer at UOW (refer, Table 3.19, 3.20, 3.21).

3.4.3.4 Evaluation model for workshops

Participants completed the training evaluation forms collected at the end of the workshop in spring (February / March) 2012. Parry and Berdie (2004), evaluate for each Course level *Satisfaction*, *Opinion*, *Knowledge Acquisition*, *Knowledge Comprehension*, *Skill Demonstration* and questions used to address each of these areas was incorporated into the evaluation system used to obtain feedback on the quality and relevance of the training. Also considered an important component of good professional development, is documentation of subject structures (Parry and Berdie 2004), (refer, Appendices 9-12). Addressing Kirkpatrick's (2006) concerns in relation to staff development the evaluation form developed gathered staff *reactions* to the use of the Tablet PC in lectures and its use in producing video resources with the Camtasia Studio software. Evaluations were also used to suggest changes and refinements to the staff development program (refer, Table 3.36). The last level, addressed by the Kirkpatrick model addresses *Skill Transfer* focusing on evaluating the trainees' performance on the job. This level requires the trainee to apply new knowledge and skills in situations explained in Section 3.4.3.5.

Table 3.36 Training Evaluation Form

Q1. Was your interest held? *(Satisfaction)*
Q2. Did the course give you ideas about how to: *(Knowledge Acquisition)*
Integrate the Tablet PC into the teaching process
Produce video resources by using Camtasia software.
Combine learning resources using Learning design
Use Summertime Math DVD / or similar.
Use Evidence based evaluation to guide change
Q8. Overall, how would you rate the course? *(Satisfaction)*
Q9. What things from this workshop do you think you would like to apply to your academic work? (*Knowledge Comprehension)*
Q10. What would you recommend changing about the training? *Skill Demonstration.*
Q11. What additional training (if any) would be helpful? *Opinion.*
Q13. Do you have any further comments, observations or suggestions *Opinion*

Note: Classification of question in italics not included on form

3.4.3.5 Student surveys

Students taught by a staff member chosen to trial the teaching tools within one of their subjects were asked to complete a survey. The staff member and 35 students were asked for their experiences with the use of Tablet PC technology over the one-

week trial period. The aim of the student survey was to evaluate the effectiveness of the tablet technology and resources produced with it, albeit in the short term. As per ethics requirements, students were informed that the primary purpose of the survey was to provide feedback that could assist in the development of the subject for future students and that the aim of this innovative use of the technology was to improve mathematics learning. The survey asked questions regarding the lecturer's use of the Tablet PC and its best features (refer, Table 3.37).

Table 3.37 Student sample survey regarding the use of a Tablet PC

1. The lecturer's use of the Tablet PC
    a) Supported or enhanced my learning
    b) Helped me actively engage with learning in the class
    c) Greatly improved visual or PowerPoint presentations.
    d) Helped me learn the subject content more easily
    e) Tablet was a really effective medium for teaching
    f) It aided learning as it clearly showed how to reach solutions
    g) Other. Please specify

The survey included open-ended questions about the innovation, the use of Maple during lectures and, more general questions as to, how to improve the subject in accord with this aspect of the Parry and Berdie (2004) model (refer, Table 3.38).

Table 3.38 Student survey: Open-ended questions

Q1. Did the lecturer's use of Maple to demonstrate the Newton method aide your understanding
Q2. Can the course be improved by incorporating the use of a software package such as Maple?
Q3. Is there a better structure for the subject that could help you to learn more effectively or efficiently?
Q4. Is there one thing you would like to see improved in the design and delivery of this subject? What would it be?
Q5. Are there any other comments about the use of the tablet or anything that could be used in this subject to make it easy to learn?

3.4.4 Identification of possibilities

Taking advantage of what has been learned elsewhere from the literature, artifacts, surveys, interviews and reflections is important if the education gap between developing Middle Eastern nations and developed Western nations is to be closed. In the next chapter, the *Redesign of eLearning,* the researcher will start her journey and immersion into the processes at UOW to identify best practices regarding the use of technology in tertiary mathematics education.

4 Case Study 1: Redesign of eLearning

This case study was conducted in the School of Mathematics and Applied Statistics (SMAS), at the University of Wollongong (UOW) with a view to identifying which resources to improve in order to facilitate better student learning outcomes. The evaluation was undertaken by students who took the subject MATH151 during the autumn terms of the 2010, 2011 and 2012 academic year. Data collection was used to discover which resources had the greatest potential for improvement or replacement and to examine if the structure of the subject could be improved for better student understanding and learning. The survey was also employed to evaluate the effectiveness of the eLearning page, and this led to an emphasis on finding an alternative learning design.

4.1 Introduction

It is widely recognised that for many students, the first year poses a challenge as they adapt to university-style learning. The challenges may include: coping with different levels of skills and workload, such as, assignments; varied teaching methods; working with other students and lecturers (Ligadu, Abbas & Han, 2012); adjusting to university life (Bojuwoye, 2002); peer pressure (Chagonda, 2001); time and task management (Moyo, 2001); pressures of working and constraints of travel mean that they no longer spend all day on campus (Whatley & Ahmad, 2007); and poor subject online design (Bonk & Dennen, 1999).

Within the framework of identifying best practice at an Australian university this case study is motivated by challenges in the design of learning materials and their delivery through a blend of traditional and eLearning environments. Building on Oliver & Herrington's (2001) model that directs attention to resources, tasks and supports in designing online learning environments, this study explores a learning design model applied to an introductory subject (MATH151). The underlying questions asked are "How can resources and tasks best be combined in eLearning site to support student learning?", "How in the design process can the temporal aspects of the subject be linked to resources?" and, "How can students be better engaged in the learning process?" Engaging students in mathematics and the practice of mathematics is problematic. How do you convince students to complete examples

and practice? This sort of question inspires reviews and revisions of subjects with for example resources being organised to support the learning process in ways that suit and adapt to the characteristics of students (Franzoni & Assar, 2009). A key issue for lecturers relates to how they can engage students as participants who are active, interacting with learning resources and how to help students learn in effective and interesting ways. Boud and Prosser (2002) argue that the design of learning activities for a particular subject involves understanding how educators challenge students' experiences of the field of study, their present understandings, and helping them to develop their self-critical skills and through this to engage students in learning. Whereas, Hanson and Heller (2007) focus on the design of academic programs which are based

> *on the disciplinary content of what should be taught while other issues important for success in subjects, such as, how students learn most effectively, how essential learning process skills can be nurtured, and, for first-year students, how the difficult transition from high school to college can be facilitated* are overlooked *(p. 1)*

These days, whether alone or blended with traditional teaching, many tertiary institutions use eLearning sites to facilitate student learning. Technology is seen as offering the potential to improve students' learning (Cradler, McNabb, Freeman & Burchett, 2002; Franzoni & Assar, 2009; Jamil & Shah 2011). The starting point for examining design can vary from lecturers who wish to develop a subject related to their interests to a department reviewing its portfolio of subjects in an attempt to identify areas which require strengthening (Franklin, Armstrong, Oliver & Petch, 2004). Planning and understanding the demands in subject provision is the first concrete phase of any new subject but typically builds on the reviews of previous subjects as well (Franklin et al., 2004). Pressure from students is a frequent motivating force!

When designing, one is confronted with a choice of adapting many pedagogical approaches. For example, one approach suggested that to improve learning experiences of students, they should have the opportunity to revisit material (Barrett, Lewin-Jones, Mitra & Williamson, 2009). Allowing students to have independent access to resources enables them to develop their own learning styles preference. If the resources are well designed and student-focused this can lead to increased academic achievement and improved student attitudes toward learning (Coffield,

Moeley, Hall & Ecclestone, 2004).

4.2 This study

The focus of the visual representational structure in this study, (MATH151), was to communicate to students the objectives of the subject, the activities that they must perform and the support that is available to help them to both complete the activities and to learn. In this way the definition of learning design was extended from guiding the lecturer in the design of learning through a learning design map to using a map or visual structure to improve students' awareness of what they have to do, when it has to be completed and the resources available.

In the search for answers to the questions "How can resources and tasks best be combined in eLearning site to support students in learning?" and "How can students be better engaged in the learning process?" the initial focus was to understand what constitutes the elements of a good learning design and therefore to evaluate the impact of changes in learning design on student learning.

The study design involved four stages: the baseline phase, *Redesign 1*, *Redesign 2,* and *Best of Lessons Learned* (refer, Figure 4.1). The major ideas that could be distilled from the outcomes of the data gathering were used as input into the fourth stage, a professional development program for delivery in the Middle East (Chapter 6).

The baseline data provides a starting position to determine how resources are currently combined and organized in eLearning. The first step involved initial subject selection and this was aligned with the selection of a lecturer to work with and the source of students, artifact analysis and baseline data gathering. In choosing the subject it was determined that the lecturer chosen was amenable to having a researcher innovating and exploring new educational ideas in their subject. The innovations and ideas of interest included the use of eLearning site and learning designs that incorporated the use of video technology and tablet technology as a tool for the creation of resources and delivery of lectures. Following the selection of the subject *Next Step* discussions were undertaken with the lecturer to identify resources used in the subject and as identified in methodology, Section 3.2.5.3 for the creation of the *Change Evaluation Survey*.

Literature Context	**How to improve mathematics education.** **A study focus on learning design based in a Western context**
Baseline implementation	Choice of subject and students; discussions with the lecturer **Artifact analysis.** The primary artifact for this analysis was the eLearning site Student *Change Evaluation* data collected: baseline evaluation data including students' suggestions for improvements Further *Next Step* discussions with lecturer about the need for improvement given students' evaluation
Redesign 1 implementation	Redesign: 1) textbook changed, 2) orientation videos for the first five chapters added, 3) redesign of the online structure, 4) time table of the assessment added, 5) group project added Student completion of subject Students complete *Change Evaluation* providing suggested improvements Researcher analysis and *Next Steps* discussion with lecturer
Redesign 2 implementation	Redesign: 1) More orientation videos for remaining chapters added along with video worked example for three chapters, 2) Online structure redesigned, 3) References to relevant books in the library for each topic were added, 4) SMAS generic outline added, 5) Head-Start program initiated Student completion of subject *Change Evaluation* including asking students for suggested improvements and suggestions for Redesign of the subject
Best of lessons learned	Study professional development strategies Implications for Designing and Testing a Professional development program for Middle Eastern Academics staff

Figure 4.1 The study design

4.2.1 Next Steps Discussion

The first part of the discussion with the subject co-ordinator was to develop an understanding of the MATH151 context. For example, in MATH 151 the lecturer, during the first five lectures, addresses the transition to university through a revision of assumed knowledge from high school, supported by a set of learning resources Summertime Math (http://www.math.uow.edu.au/subjects/summer/topics/functions.html). The second was to identify what resources were provided to students in MATH151 as these resources were to be evaluated by students in the *Change Evaluation* survey.

4.2.1.1 Baseline performance

One of the reasons for seeking to work with the co-ordinator and lecturer of the subject chosen was that the subject had a high failure rate. In 2010, the period for which additional baseline data was collected, the failure rate was 28.7%. Discussion as to the *Next Steps* to be undertaken to improve MATH151 canvassed reasons for the failure rate (refer, Table 4.1).

Table 4.1 Failure Rate in MATH151

Years	Number Enrolled (N)	Student Failed (F)	Pass conceded (PC)	(F+PC) / N (%)	Mean mark	Median mark	Standard deviation
2010	128	34	12	35.9	54	55	21.27
2009	112	27	7	30.4	58	63	23.51
2008	97	23.7	3.1	26.8	59	62	21.7
2007	94	38.3	7.4	45.7	50	54	22.0

* The Failure rate for all years is defined as in 2012 when students previously awarded pass conceded be awarded a fail grade ie there will be a difference in rates when compared to previous tables.

From the lecturer's perspective the failure rate is high. In 2010 at the commencement of this study the lecturer believed that there were many reasons for the high failure rate. One major reason was poor background skills. Over the period 2007-2010, the lecturer believed there were an increasing number of weak students enrolling in the subject who did not have mastery of the presumed knowledge of topics such as fractions, algebra, indices and factorisation. The lecturer also considered that there was too much time spent covering very basic material and consequently the final topics were covered very quickly: differentiation in one week and integration in one week. This was not considered an adequate preparation for these topics. The discussion with the lecturer was about how to ensure students made full use of the resources that have been developed for the subject and were available through the eLearning site. This discussion led to an emphasis on the redesign of eLearning, the next steps for the researcher.

4.2.1.2 Teaching delivery

Lectures were delivered to students for thirteen weeks. The subject comprises five hours per week of lectures, practical and tutorials in addition to self study. Face-to-face teaching took place in two forms, lectures and tutorials. The lectures were the major organizational component with practical classes and tutorials provided to reinforce what was taught in lectures and to give students an active learning space where they were the ones undertaking the activities or exercises.

The total teaching time per week of five hours traditionally consisted of three hours per week lectures, a one hour per week practical class and one hour per week tutorial. In more recent years the practical class is only used for the first seven weeks of session and in the remaining six weeks there are four hours of lectures and a one hour tutorial class.

Two lecturers teach the subject, one taking the first seven weeks and the second, the final six weeks. In addition students had one small group tutorial of about 15 students for 1 hour per week.

4.2.1.3 Lectures and text book

The lecture material corresponded to topics covered in the textbook, written by previous and current lecturers. Only topics considered appropriate for Science students are included in the student textbook. Chapters are numbered: 0) Introduction, 1) Indices, Surds & Algebraic Fraction, 2) Logarithms, 3) Function Notation, 4) Straight Lines, 5) Trigonometry, 6) Exponential Growth and Decay, 7) Data Modelling, 8) Limits, 9) Differentiation, and 10) Anti-differentiation. Each chapter starts with the identification of the aims of the chapter (refer, Figure 4.2). Following this concept, the subject content is provided for each topic. Each chapter ends with three sections. The first section contains questions about the chapter's key ideas. The second section has questions where, for the most part, the final answer, not the complete solution, is provided. Finally, there is also a reminder for students that there is a document in eLearning site that lists books relevant to the chapter and comments about the history of the development of ideas.

Chapter 1

Indices, Surds and Algebraic Fractions

- Aims

After working through this chapter you will:

- Know what the expressions a^n and a^{-n} mean, where 'a 'is a real number and 'n' is an integral.
- Be able to use the laws of Indices to simplify expressions.
- Know how to simplify fractional surd expressions, to obtain a non-surd denominator.
- Know how to simplify algebraic fractions.
- Be able to expand $(a + b)^2$ and $(a + b)^3$ using Pascal's triangle.
- To factorize simple expressions

Figure 4.2 Aims for Chapter 1 in the MATH 151textbook

A second feature of the textbook was that the lecturer embedded science context into some mathematics questions. Students did not need to understand the science content

to do the questions but it showed them where mathematics is used in science (refer, Figure 4.3).

Application: Biological Growth

When one celled organisms reproduce by simple cell division in a culture with an unlimited supply of nutrients, the rate of population growth is exponential, i.e., satisfies a formula of the form

$$\boxed{p(t) = ce^{kt}}$$

Where p(t) is the number of organisms present at time t. Usually, we find that c=p(0).
First note that we will use the following results from Chapter 1

$$a = e^{kt} \text{ if and only if } kt = \ln a \text{ ; and } e^{\ln(\,)} = (\,)$$

Egs. $e^{\ln(6w)} = ------- \quad e^{t\ln 2} = ------- = --------$

Example:

The rate of population growth of bacteria grown in a certain culture is exponential. There are 2500 bacteria present initially and the number of bacteria triples in $^1/_2$ hour.

- How many are present after t hours? After 2 hours?
- How long before the number of bacteria doubles?
- How long before there are a million (10^6) bacteria present?

Figure 4.3 Science questions in MATH151 textbook

4.2.1.4 Practical class

From 2007-2012 the practical classes followed the lectures, for a third hour of a three hour block during the six weeks 2-3, 5-7 & 9-11. During the one hour of the practical class, the lecturer and three helpers worked with students applying the lecture material to problems.

4.2.1.5 Tutorials

In weeks 2–13 each student attends a one-hour tutorial. The tutoring in MATH151 took place in a "whiteboard" room (refer, Figure 4.4). All walls of the room have whiteboards and each student is to complete their tutorial problems on the boards. In this way the tutor can see and assist students as they work, and students can see the progress or solutions of other students.

Figure 4.4 Tutorial room
Courtesy of Dr Caz Sandison

The main issue with this form of tutoring was that students were not able to retain a copy of their work, unless they wrote it down on paper at the time of whiteboard

completion. In current classes students can copy their solutions with an iPad or phone, but this was largely unavailable during this study. At the end of each week students are supplied with solutions for the problems worked.

During tutorials students work individually, practising material that is covered in lectures. In the tutorial, the types of questions involve learning by doing mathematics questions, (refer, Figure 4.5) and mathematics in science questions (refer, Figure 4.6).

Learning by doing

Learning is mathematics is achieved by "doing it". The following question can be solved using mathematical techniques that are covered in chapters 1 & 2 of the course.

You should spend the first **twenty minutes** of your tutorial working your way through these questions. (You can return to any questions that you do not finish latter).

1. Simplify the expression $\frac{1}{x+1} - \frac{1}{x}$.
2. Simply the expression $x^4 \times x^2$.
3. Expand $(3x - 2)(x + 1)$.

Figure 4.5 Learning by doing mathematics

Science questions

n these questions you use mathematical ideas to solve simple science problems. If you finish these question before the end of your tutorial you should finish all remaining questions from the first and second sections o he tutorial sheet.

1. The definition of pH is

$$\mathrm{pH} = -\log\left[\mathrm{H}^+\right],$$

where $[H]^+$ is the concentration of hydrogen ions measured in units of $\mathrm{mol\,dm}^{-3}$.

(a) What is the pH of a solution containing a concentration of hydrogen ions of $10^{-5}\,\mathrm{mol\,dm}^{-3}$?

(b) In a sample of orange juice the concentration of hydrogen ions is $3.16 \times 10^{-4}\,\mathrm{mol\,dm}^{-3}$. What is th pH of the solution? (3.5

Figure 4.6 Extract from Science questions

Another focus of tutorial work is to build skills in checking work, in spotting errors (refer, Figure 4.7) and using Wolfram Alpha (refer, Figure 4.8).

Where are the errors?

The purpose of these questions is to engage your mental powers in a different way to that used in the previous section. The following questions are based on errors taken from exam papers. Finding the errors in these solutions will enhance your understanding of the mathematical techniques used. You should spend no more than **ten minutes** on these questions.

1. Let $\sqrt{2} \times \sqrt[3]{2} \times \sqrt[5]{2} = 2^x$. Is the following calculation correct? If not, explain where the error is

$$\begin{aligned} 2^x &= \sqrt{2} \times \sqrt[3]{2} \times \sqrt[5]{2}, \\ &= 2^{1/2} \times 2^{1/3} \times 2^{1/5}, \\ &= 2^{1/2 \times 1/3 \times 1/5}, \\ &= 2^{1/30}, \\ \Rightarrow x &= \frac{1}{30}. \end{aligned}$$

Figure 4.7 Find the errors

WolframAlpha

The website WolframAlpha (`www.wolframalpha.com`) can do many calculations. It's worth knowing about as a way to check answers. For example, try inputting the following expressions into the engine. You'll have to try this outside the tutorial!

1. `(a^2)^0/a^3`.
2. `2/(sqrt(5)-sqrt(3))` (Look at 'Alternate forms')
3. `expand (-x-1)*(x-3)`

Figure 4.8 Questions for Wolfram Alpha

4.2.2 Artifact analysis: theoretical perspectives

The structure of a subject and the nature of its delivery can be described in terms of several learning theories even though the lecturers may not be aware of them.

Reflecting behaviourist principles in MATH151, learning objectives for each chapter were provided both in video and text formats. Learning resources and support are provided to students in the eLearning sites. In MATH151 the within-session learning assessment elements consisted of three in-class tests with a retest for the first two, three tutorial assignments, three online quizzes and an optional group research project. Further, each content area in the subject had an online self-test so students could test their knowledge. In addition, feedback was provided in the form of worked solutions when the marked assignment was returned. Feedback is a key behaviourist strategy wherein the teacher's manipulation of the learning environment can be used

to promote learning. However, the subject coordinator was using the learning theories unconsciously because he was not aware of the theoretical perspective when designing the subject.

The redesign of an eLearning site sought to develop the site in terms of cognitivist principles by adding more visual and video resources. In the orientation videos, the importance of the chapter, objectives and other relevant was highlighted to help motivate student to learn. Activities in the Summertime Math online repository of mathematics learning resources were used to enable students to identify the specific skills that are required for their first session of tertiary mathematics studies and to review those skills before starting their subject. The resources catered for different learning styles, audio and visual, so students could choose their preferred style and select easier or harder work to undertake. According to Ally (2008) students should be given the opportunity to complete assignment and projects that use real life application and information. The coordinator has done this by adding the application problems to the assignments to show students where mathematics is used in a science context.

The design of learning activities in MATH151 reflected constructivist principles including collaboration, real world examples, self-reflection, multiple representations of ideas, and social negotiation. In the context of this study, the eLearning system has been used to extend the use of social processes. For example, students may work in a group to complete their assignment. There is an optional group project assessment. Student interaction with the lecturer was prompted in the eLearning forum (refer, Figure 4.9) as was student to student interaction. Ally (2008) explains that working with other learners gives learners real-life experience of working with a group and allows them to use their meta-cognitive skills and to learn from others (Ally, 2008).

As eLearning designers, it is important to convince the learner that the course will be worth their while (Hext, 2012). To encourage self-directed active learning the lecturer provided students with resources to solve problems and with guidance, group discussion, projects and feedback. In the first case study the lecturer made clear learning objectives for each topic through the production of orientation video resources.

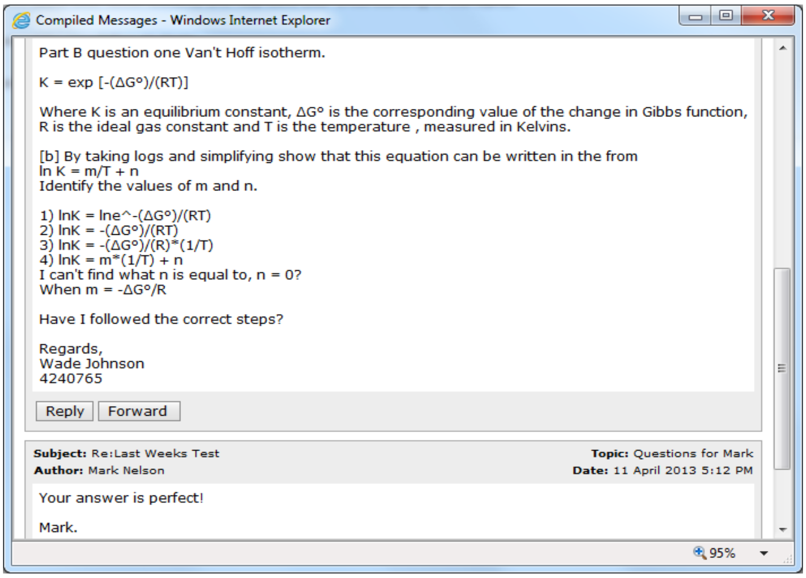


Figure 4.9 Student and lecturer interaction in the eLearning forum

4.2.3 Artifact analysis: eLearning site

The need to organize resources in an eLearning environment to help students study effectively by providing good support and appropriate "scaffolding" has been emphasised (Xiaozhen & Yun, 2002; Kuo, 2008). An eLearning environment is able to provide "*enhanced input and abundant learning resources and aids*" Kuo (2008, p. 297). Oliver & Herrington (2003) argue there is a "*need to plan learning settings based on meaningful and relevant activities and tasks which are supported in deliberate and proactive ways*'' (p. 111). There are many ways to improve teaching and learning by organizing the structure of eLearning sites and providing appropriate online learning strategies, activities and resources and supports. In terms of the redesign of eLearning, the primary artifact for analysis was the eLearning site. The baseline or original eLearning site used the list menu (refer, Figure 4.10) and the more often viewed icon menu (refer, Figure 4.11).

Figure 4.10 Extract of the home page by a menu

The main view to the home page, in Figure 4.11, was provided by a set of icons. Each page consisted of a series of links to lecture material, and learning activities, such as online quizzes and tutorial sheets, learning resources, including solutions to mathematics questions covered in lectures, collections of worked examples and additional supports, such as access to the eLearning discussion forum.

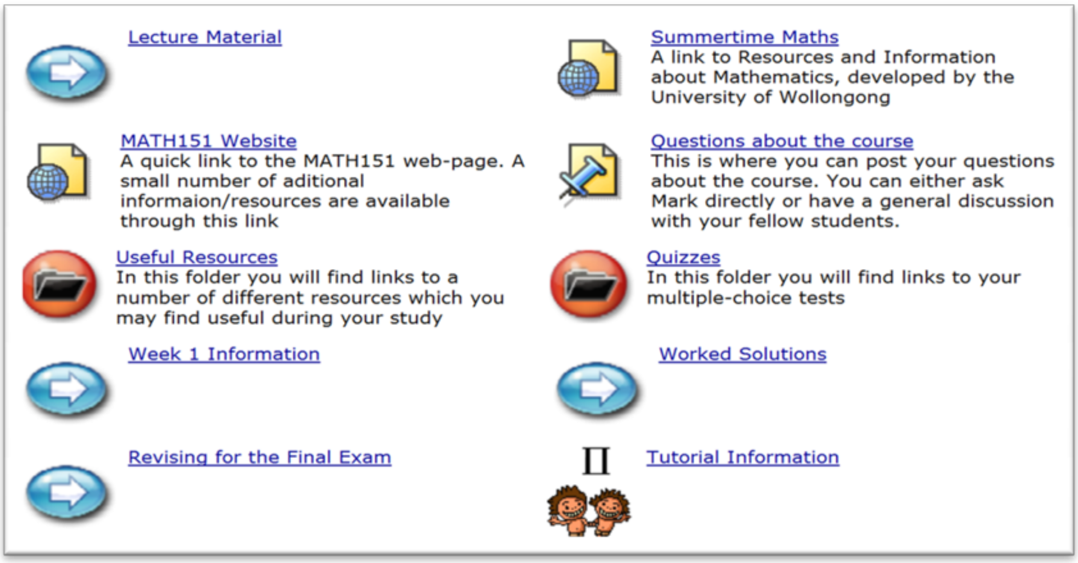


Figure 4.11 The original eLearning website for MATH151

Each link in Figure 4.10 or icon in Figure 4.11, led to secondary pages that contained either files or further links.

4.2.3.1 Lecture Materials.

This page provided a collection of different resources from each chapter with assessment example and answers (refer, Figure 4.12).

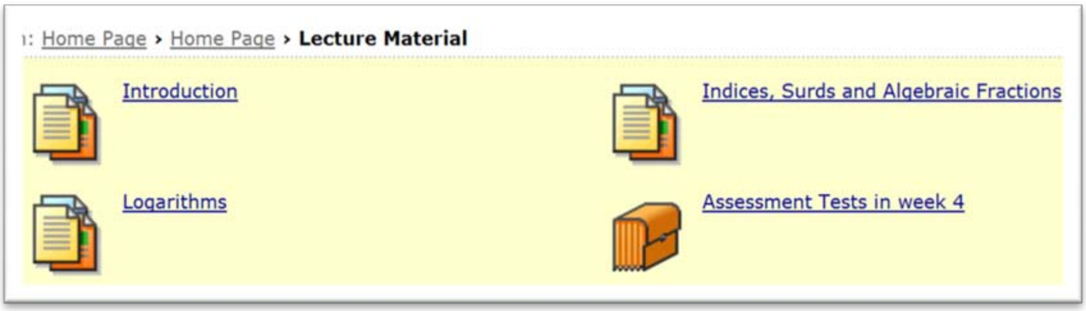


Figure 4.12 Extract from lecture material page

The links on *Lecture Materials* page were predominantly about topic information (refer, Table 4.2).

Table 4.2 Information on each topic link

Indices , Surds & Algebraic Fractions	This includes worked solutions for textbook exercises for indices with additional questions with worked solutions for algebraic, indices, re-arranging, factorisation and surds. It also contained surds and algebraic fractions, summary, self-tests on algebraic fractions, indices and on surds and additional resources for indices, surds, algebraic fractions
Logarithms	Worked solutions for textbook exercises and additional questions with worked solutions link to a pdf file, self-test on logarithms and additional resources for logarithms.
Straight Lines	Additional questions with worked solutions and self-test on straight lines
Trigonometry	Worked solutions for text book exercises and self-test on trigonometry
Data Modelling	Self test on data modelling
Exponential Growth & Decay	Self-test on exponential growth
Differentiation	Self-test on differentiation
Limits	Self-test on limits
Integration	-

The remaining information on the lecture materials page provided information for tutorial questions, tutorial solutions, quiz, tutorial assignment task, self-test on each topic and additional questions with worked solutions (refer, Table 4.3).

Table 4.3 Information on each link

Introduction	Covered in weeks 1-3 of the semester the link contains all the information for the topic including lecture notes, tutorial questions, tutorial solutions (released at end of each week), quiz, tutorial assignment task and video of worked examples via the link to Summertime Math.
Assessment Tests, Week 4	It contains a pdf file on the multiple choice quiz, practice test 1 and its solutions.
Assessment Tests,Week 8	Practice test 2 and solutions. Multiple choice quiz 1, solutions, multiple choice test 2 and solutions
Assessment Tests,Weeks 12 & 13	It contains • Multiple Choice Quiz: .pdf which is a practice test for the on-line week 13 test. This test will predominantly cover "Exponential Growth and Decay", "Data Modelling", "Limits" and "Differentiation". It does NOT cover "Integration" • Multiple Choice Quiz Solutions • Practice Test 1 test3prac.pdf This is a practice test for the week 12 in-class test, This test will predominantly cover "Exponential Growth and Decay", "Data Modelling" and "Limits". It will NOT cover "Differentiation" or "Integration" • Practice Test 1 solutions

The layout for each topic followed a similar format to the example for the Indices, Surds and Algebraic Fractions topic, as provided in Figure 4.13.

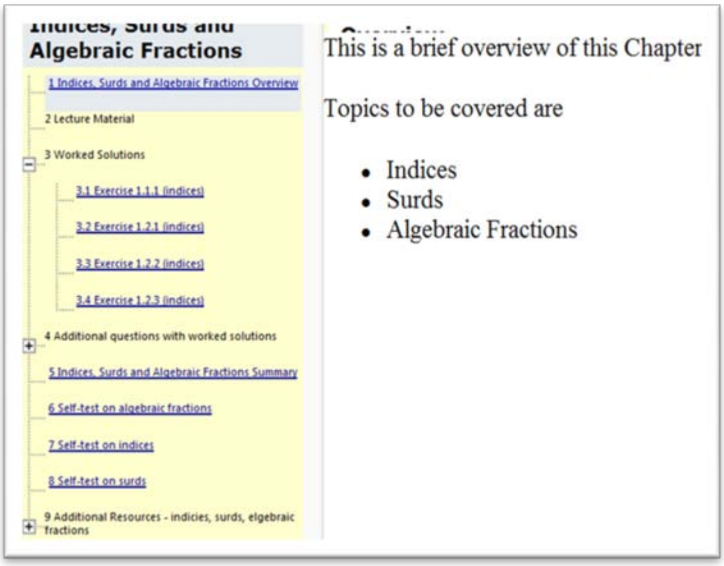


Figure 4.13 Indices , Surds and Algebraic Fractions link

4.2.3.2 MATH151 Website

The MATH151 website at http://www.uow.edu.au/~mnelson/teaching.dir/math151.html links to a page which contains a small number of additional information resources including: content, student consultation, worked solutions to exercises, assignments, practice test paper, optional tutorials, project information, answers to previous exam papers, miscellaneous and timetable for study assistance during study week. Almost all of the material for this subject is distributed through the eLearning site. This web page is only used for emergency situations, such as the eLearning site being unavailable. For the lecturer the supplementary information is easier to maintain and update for the web page than it is in the eLearning site

4.2.3.3 Summertime Maths

The *Summertime Maths* page provided a quick link to a number of additional information/resources for algebraic fractions, indices, surds, logarithms, Cartesian geometry, functions, intermediate trig and advanced trig. It is developed and created by Mathematics staff at UOW (refer, Figure 4.14). It provides a variety of resources for each topic including self-tests with hints and written solutions; theory refreshers; worked solution with live video solution and a written solution; practice questions with answers and links and texts to link students to Math tutor. (http://www.mathtutor.ac.uk/arithmetic/fractionsbasicideas).

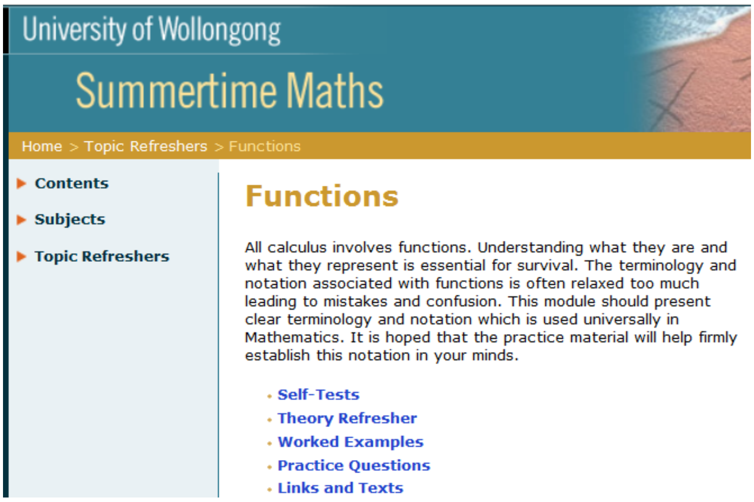


Figure 4.14 Summertime Math

* Data Sources (URL: http://www.math.uow.edu.au/subjects/summer/topics/functions.html)

4.2.3.4 Question about the course

The *Question about the course (Discussion forum)* page (refer, Figure 4.15) provided a place for students to gain some support in their studies by posting their questions about the subject. Students could either ask lecturers directly or have a general discussion with fellow students.

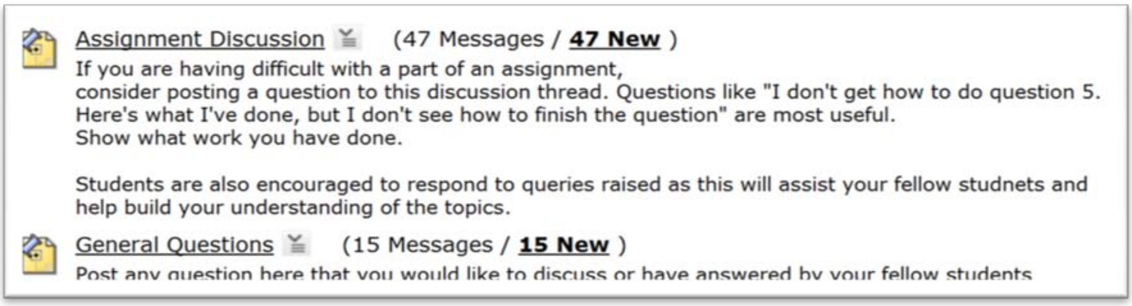


Figure 4.15 Questions about the course

4.2.3.5 Useful Resources

This page also provides students with links to a number of different resources such as maths in action videos that students may find useful during their study.

4.2.3.6 Quizzes

This page provided students with links to their multiple-choice tests for the weeks 4, 8 and 13 together with explanations of which topics were included in each quiz (refer, Figure 4.16).

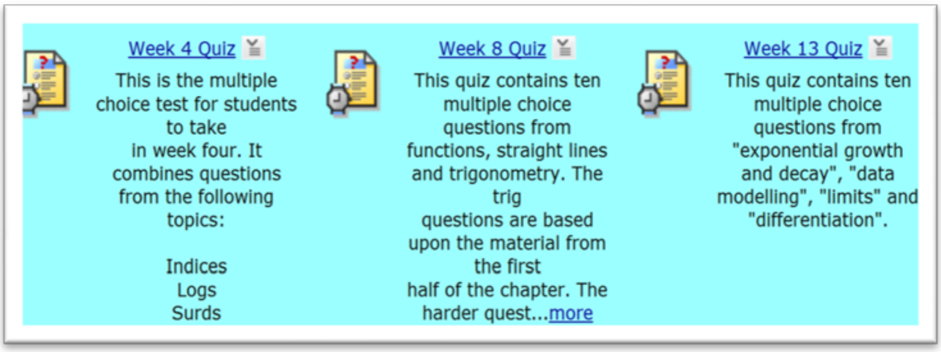


Figure 4.16 Quizzes

4.2.3.7 Week 1 Information

The *Week 1 Information* page provided students with access to Subject Information 2010 containing the subject outline, details of who is lecturing, assessment details, details on tutorials and other policy information. The Subject Information Presentation contained the same information presented in a different way (layout).

4.2.3.8 Worked solutions

The *Worked solutions* page contained solutions to exercises worked in lectures, that is from the textbook, and where appropriate a note regarding corrections and date of posting (refer, Figure 4.17).

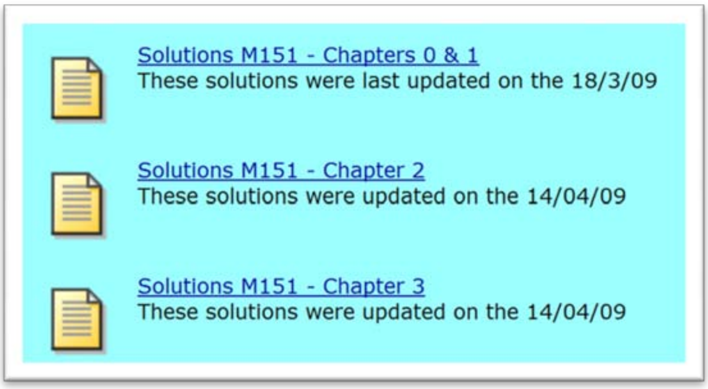


Figure 4.17 Extract from the worked solutions link

4.2.3.9 Revising for the Final Exam

The *Revising for the Final Exam* page (refer, Figure 4.18) provided a past examination paper. There is also an exam paper in the back of the MATH151 textbook.

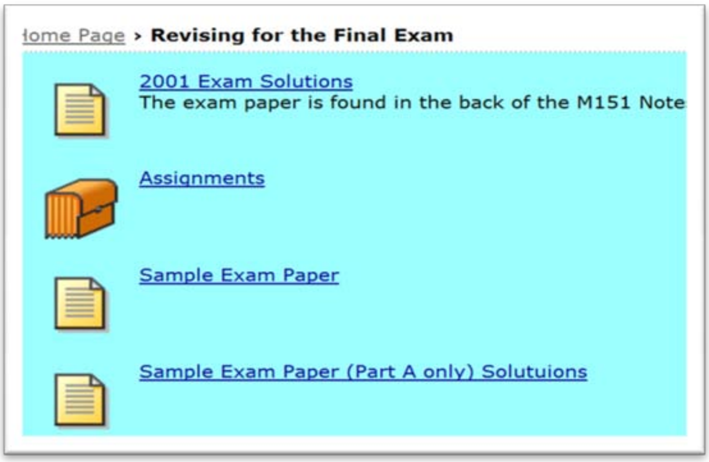


Figure 4.18 Extracts from the link revision final exam

4.2.3.10 Tutorial Information

The *Tutorial Information* page contains the tutorial sheet for week's 2-13 a (Figure 4.19).

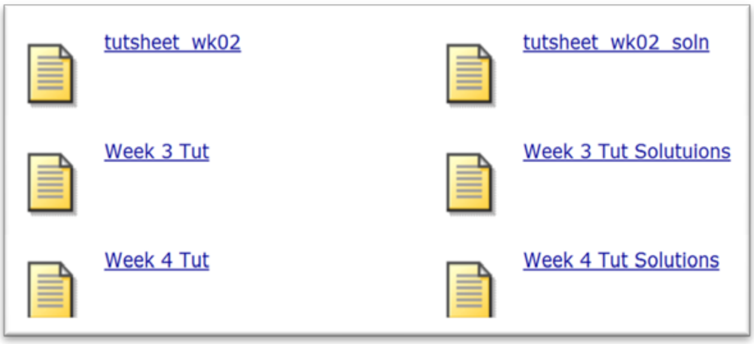


Figure 4.19 Extract from tutorial information link

Each tutorial the lecturer uploaded worked solutions to this page (refer, Figure 4.20).

2. (i) $$a^{1/2}\cdot a^{-1} = a^{1/2-1} = a^{-1/2} = \frac{1}{a^{1/2}}$$

(ii) $$\frac{1}{a^{-1/2}} = a^{1/2}$$

(iii) $$a^{-2}x^{-1} \div xa^{-1} = \frac{1}{a^2x} \div \frac{x}{a} = \frac{1}{a^2x} \times \frac{a}{x} = \frac{a}{a^2x^2} = \frac{1}{ax^2}$$

Figure 4.20 Extract of worked solution

4.2.3.11 Problems with the eLearning site

The structure of the eLearning site did not convey the temporal sequencing of activities, or the appropriate time to access resources and to complete tasks. An

examination of these links and resources suggested reorganisation of resources in several places. There is also an absence of material related to assessment timetabling, this being included in the subject outline given out in class. This analysis of the website with a view to aligning resources, activities and supports, together with student comments (Section 4.2.3) led to suggestions for restructuring the eLearning site.

4.2.4 Student participation

The numbers of students enrolled in MATH151 together with the numbers responding to the *Change Evaluation Survey* during the autumn term of the 2010 (baseline), 2011 (*Redesign 1*), 2012 (*Redesign 2*) academic years are reported in Table 4.4. The surveys which were completed voluntarily, after the provision of a *Participant Information Sheet*, were given out in the final lecture for each of the three years, however a variable number of students were in attendance, resulting in different response rates ($\mathcal{X}^2$ =56.311, df=2 p<.0005), when seen as a percentage of enrolled students.

Table 4.4 Student numbers and response rate

Year	Implementation	Students enrolled	Students responding	Response Rate %
2010	Baseline	128	101	78.90
2011	Redesign 1	145	49	33.79
2012	Redesign 2	119	60	50.42

Before examining the students' *Change Evaluation* of the subject, the demographic profile of students completing the survey over the three years is provided. This allows the evaluations to be examined through a frame that indicates whether or not the composition of the subject has remained the same. The breakdown of students in terms of sex (male/females) and origins (domestic/ international) as revealed in Table 4.5 indicates a low number of international student respondents in each of the three years and suggests the proportion of male and female students overall is similar, with no significant difference ($\mathcal{X}^2$ = 1.495, df = 1, p-value = 0.222) when using chi-square to compare the proportion of male and female students for years 2010 to 2012. Assumptions to the application this chi-square test as were discussed in Section 3.1.1 were met.

Table 4.5 Number of students completing the Change Evaluation

Year	Gender of students	Domestic students		International students		Total	
		N	%	N	%	N	%
2010	Female	37	36.6	6	5.9	43	42.6
	Male	44	43.6	14	13.9	58	57.4
	Total	81	80.2	20	19.8	101	100
2011	Female	21	43.8	3	6.3	24	50
	Male	23	47.9	1	2.1	24	50
	Total	44	91.7	4	8.3	48	100
2012	Female	28	45.9	4	6.6	32	52.2
	Male	26	42.6	3	4.9	29	47.5
	Total	54	88.5	7	11.5	61	100

4.2.5 Outcomes at baseline

The *Change Evaluations* addressed the following questions:

- How effective is the current subject in terms of impact on students' confidence or perceived competency?
- How effective are the offline resources in terms of usefulness in helping students understand?
- How effective are the online learning resources in terms of usefulness in helping students understand?
- How effective is the design of the eLearning site in terms of its provision of attributes such as clarity or good access to materials?
- Can other potential improvements be identified that may lead to an improvement of mathematics education for these students?

4.2.5.1 Perceived competency

An analysis of perceived student competency, that is the percentage of students being confident in their ability to undertake problems in a given topic area, ranged from 42% for *Data Modelling* to 87% for *Straight Lines* (refer, Table 4.6).

Table 4.6 Students' perceived competency with the mathematics chapter

Presentation Order/ Chapter Number	Topics	Can do & Moderate Confidence	
		N	%
4	Straight line	87	87.0
1	Indices	86	86.0
0	Algebra	85	85.9
5	Trigonometry	84	84.0
3	Function Notation	79	79.0
2	Logarithms	65	65.0
9	Differentiation	63	63.0
8	Limits	51	51.5
6	Exp. Growth & decay	50	50.0
10	Integration	48	49.0
7	Data Modelling	42	42.4

The five topics rated lowest are all from the second half of the subject where possibly the lack of confidence is compounded because there is less time to consolidate the work and the material covered in these topics is also predominantly new material, whereas the material for Chapter 0, *Algebra*, Chapter 1, *Indices*, and Chapter 3 *Function Notation*, should have been encountered at school by most students; whereas Chapter 2 *Logarithms* would have been new to most students.

4.2.5.2 Valuing of offline resources

One question that arises from the perspective of engagement is how useful do students find the learning resources provided. Indeed the feedback from students ranged from 64% who found the Peer Assisted Study Sessions (PASS) tutorials useful to 84% considered the lectures useful. Another way of considering these percentages is to reflect on the percentages failing in the baseline year of 2010 (28.7%) and the percentages not finding the resources useful, which ranged from 16% to 36% (refer, Table 4.7).

Table 4.7 Ratings of the usefulness of offline learning resources

Existing learning resources	Total of extremely useful & Moderate use	
	N =101	%
Lectures	85	84.2
Assessments	83	83.0
Tutor in Practical class	82	82.0
Worked solutions	81	81.8
Work in Practical class	79	79.0
Textbook	78	78.0
Other work done in your own time	76	75.2
PASS	63	64.3

Many of these resources were not within the scope of the researcher to alter, although they allowed for reflection on outcomes from the subject. For example, “More PASS classes” were requested, but funding for additional classes is not available. Where students use PASS tutorials they have a positive response, and it would be useful to examine the nature of the tutoring that occurs in these classes. However, as with many resources, they are of use only to those students who elect to take advantage of them; they are an optional resource. Regular tutorials scheduled for all students are known to be beneficial but only if students attend them and complete the work. *Other work done in your own time* also appeared to be in the domain of the student to alter. Students did proffer comments in relation to the improvement of assessment, the textbook and tutoring.

4.2.5.2.1 Assessment, feedback and marking

Assessment is readily modifiable, as it tends to be changed every session. Over the period 2010-2012 each of these assignments contained more than ten questions. Ten questions were selected and marked. Students were provided with solutions to all questions so they could check all answers/solutions. This idea was based on the work of Frayer (2009) who argued that "*one way to get students to work more problems is to collect more than you grade*" (p. 28). Comments on assessment (refer, Table 4.8) generated a request for feedback and a mark for every question. Students also wanted an increased value placed upon "within session" assessment, reducing the value of the final examination. Students also commented on the need for better structure clearly identifying "when and where" assessment was due and could be found.

Table 4.8 Student concerns about assessment

Marking issues: More marks on the assessment (4) and less assessments; Marking all the questions we submitted would be very fine; Mark every question (4)
Assessment: Assessment has not included all topics; More take home tests; More self tests; More practical tests
Assessment information: Have a calendar telling when the assessment is due and what reading is involved; More assessment for dates, when they are, what they are on

4.2.5.2.2 Textbook

A second area identified as being readily modifiable by the lecturer was the textbook, which for this subject is written by staff. The textbook contains many worked examples with step-by-step solutions provided. Some texts use "gaps" to actively engage students so as to help them remember and understand more of the lecture material (DeZure, Kaplan, Deerman, 2001). How gaps are implemented varies. Aminifar (2007) identified notes where gaps were in theory and examples, a practice she considered to be questionable. The approach used in MATH 151 involved gaps left only for the completion of example worked in lectures and for additional exercises provided for student completion, (refer, Figure 4.21). Answers were only provided for selected exercises. One connecting thread through evaluation was the lack of practice and worked examples available and the need to improve this aspect of the textbook.

Exercise: 5.4.2

Fill in the blanks with the appropriate number.

$\pi(\text{rad}) = -------^{\circ}$ $\qquad$ $------ (\text{rad}) = 240^{\circ}$

$\frac{\pi}{3}(\text{rad}) = -------^{\circ}$ $\qquad$ $\frac{\pi}{6}(\text{rad}) = -------^{\circ}$

$-------(\text{rad}) = 45^{\circ}$ $\qquad$ $-------(\text{rad}) = 150^{\circ}$

Write down the exact value of the given the trigonometric function

$$\sin\frac{\pi}{3} = \qquad \cos\frac{\pi}{2} =$$

$$\cos\frac{\pi}{6} = \qquad \tan\frac{\pi}{4} =$$

Can you find the exact value of the following

$$\sin -\frac{\pi}{6} \qquad \cos\frac{3\pi}{4}$$

Figure 4.21 Use of gaps in the textbook for MATH151

Subject lectures vary as to the type and amount of information they provide and if the students are not in class, they will miss the lecturer's explanatory comments and supporting information. The textbook supports what occurs in lectures. Research on note taking indicates that taking notes in class and reviewing those notes either in class or afterwards has a positive impact on student learning (DeZure et al., 2001) and this is what is intended with gaps being left in the lecture notes. Gaps are used to encourage students to come to class. However, if students miss class, given there are gaps, they miss the working of examples. The analysis of the student comments regarding the texts indicated that they wanted the gaps filled, more worked examples to be provided (refer, Table 4.9) and the complete book uploaded.

Table 4.9 Students' comments regarding the textbook

Examples and Solutions: Text book with more worked example which show step by step how to solve math problems (n=12) More worked solutions/more details structures/more worked examples and fully worked solutions included; More worked solutions for all topics; Exam solutions/practical solutions/solutions from exercise text book are useful; Put the worked solutions including graphs in for the questions in lectures notes; Putting more solved problems with examples; Have more questions to practice and answers to exercises in the text book - I can't find any(n=2); More teaching materials in lectures it is difficult to just learn from eLearning
Topic coverage: Algebra totally covered but differentiation is not covered; Complete example in the lecture book, work book need to complete set of structured for each topic with example and answer (n=7); Apply mathematics for every subjects
Design: There are many gaps in the work book; Better work book with relevant question like test, concrete on the bases, step by step of worked and similar example to test and assessment; More focused on simplified explanations/more relevant examples in lectures.

4.2.5.2.3 Tutoring

Students wanted a restructuring of the tutorials (refer, Table 4.10). Students were asked questions such as "If you can imagine a better structure for the subject (lectures, tutorials, completing modules etc) that would help you to learn more

effectively or efficiently, please describe briefly below". The responses by several students primarily suggested a restructure of teaching in tutorials.

Table 4.10 Student concerns about tutoring

Restructure tutorials: The tutorial is a waste of time; Better tutorials; Rather than doing the assessment in tutorial we can complete this in our own time?; Use the tutorial to go through things that people have difficulty with or go through questions; Tutor to run through questions after a given period of time; Have the tutorial taught, the class does not work on whiteboards; This is difficult to do; There is much question repeating in the tutorial; More worked examples in tutorial; More tute time

Solutions: Tute solutions are needed to read for study in test

Complete on paper: Tutorial in white board room – there is no way to keep record/no way to check our answers; Tutorial done on paper

4.2.5.3 Valuing of online learning resources

The survey results indicated a range of responses when asked about the helpfulness of various online resources. Four of the resources were highly valued by at least 95% of students: leaving the redesign or design of eLearning homepage, self tests, other additional resources, forum eLearning as potential places to innovate. The most useful resource with 97% of students indicating was useful was a primary resource *tutorial solutions*, provided weekly covering all topics. That 79% of students found the *Summertime Math*, which covered only four of the eleven topics, useful in addition to tutorial solutions suggested there was scope for more of the Summertime Math type resources covering all topics (refer, Table 4.11).

Table 4.11 Usefulness of online learning resources

Topics	Extremely useful & Moderate use %	
	N	%
Tutorial solutions	95	96.9
Worked examples	95	96.0
Assessment solutions	96	96.0
Sample test papers	94	94.9
eLearning Homepage	90	90.9
Self tests	87	88.8
Other additional resources	84	84.8
Forum eLearning page	77	78.6
Summertime Math	77	78.6

In terms of modifying resources or design, some things are possible and others are not. With respect to the online learning resources, the modification *Summertime Math* was not possible as it was externally developed. However it was possible to consider the development of additional resources to cover topics not covered by *Summertime Math*. There was scope to improve all the remaining resources; with selection in part determined by what a third party (researcher) could manipulate with the remaining resources the province of the lecturer.

4.2.5.4 Attributes of the eLearning environment

Although students indicated that the eLearning home page and forum were useful in helping them learn and understand, it was clear from the ranking of different features of the eLearning site, such as the clarity, structure and student comments, that it could be better designed. An examination of the percentage of students finding eLearning site and its components useful revealed that components ranged in usefulness from 65%, for *What the lecturer wants is clear*, to 81%, for *access to materials*. Leaving 19-35% of students finding different components of the system not useful (refer, Table 4.12).

Table 4.12 Attributes of the eLearning environment

ELearning	Extremely useful & Moderately useful %	
	N	%
• eLearning better access material	80	80.8
• Structured to know required assessment	77	77.0
• Support through difficulties in learning	75	75.0
• Structure of eLearning page help understand objectives	74	74.7
• What the lecturer wants is clear	65	65.0

While some students found eLearning site "*to have good design/delivery*" with "*all information for the course is available in eLearning*", generally student response to an open-ended question asking how the subject can best be improved confirmed a need for redesign of the eLearning site; it was not easy to navigate and students wanted "*more examples that are easy structured and accessible for revision*". Students also wanted more information regarding assessment scheduling (refer, Table 4.13) even though this is in the subject outline.

Table 4.13 Students' responses about online resources and navigation

Design: Better online design needed (2), site is not clear (3); Better structure(2); clear folder files (2); Better access to learning materials [needed]; easier location of assessment; Material needs to be explained more clearly; online needs to be well designed; better access to learning material; online is messy (2) and some links do not work (2); eLearning is messy/difficult to find worked solutions; Fewer links to materials; clearer links; all links to work.

Needs resources: To revise we need more examples that are easy structured and accessible for revision; More online documentation, relevant problems, resources, worked solutions [needed] (2); difficult to find worked solutions to revise.

Assessment dates: which week in which assessment is due and reminders; It is difficult to find your assessment and which week it is due.

4.2.5.5 Other students' suggestions

Comments in general regarding improvement focussed on a variety of issues. Students were divided regarding the nature of the work set with some wanting mathematics problems devoid of Science with others wanting their particular

Science, Chemistry or Environmental context included in problems and others not seeing the relevance of mathematics to their chosen degrees. Students had commented in relation to various aspects of the lectures. Some preferred to have one lecturer rather than two, some wanted the lecture to be more focussed on concepts and the lecture time at night was not suitable for some (refer, Table 4.14). The timetable is not under the control of the lecturers as it is timetabled centrally by the University.

Table 4.14 Other suggestions made by students

Relevance: More theory based questions/less chemistry questions; Have more questions that are mathematics based less math in action; Not just science questions; More relevant questions for different degrees; Math is not relevant to my degree; Earth-environment subjects don't need maths in most subjects (n=3).
More resources: More PASS tutorials; More lectures.
Pace: Slow down in the lectures; More time spent explaining concepts and key concepts.
Timetabling: Time of lectures not in night (5); Make the lecture at reasonable time(1).
Lecturer: One lecturer for all semester (n=6); Different lecturer is also hard.

4.2.6 Possibilities

As identified in Section 4.2.3 there appeared to be scope to improve the design of eLearning. The students valued resources, *Summertime Math*, worked solutions, tutorial solutions, assessment solutions, but it was clear from the analysis of materials that resources were for the most part available for only the early topics. In MATH151 students had access to a limited number of videos through the Summertime Maths collection, which provided resources for the topics algebraic fractions, indices, surds, logarithms, Cartesian geometry, functions, intermediate and advanced trigonometry but not for exponential growth and decay, data modelling, limits, differentiation and integration. In response to the open questions students requested more resources, better designed resources, activities and access to all information via eLearning site (refer, Table 4.15).

The researcher in conjunction with the lecturer was in a position to develop video support for students. Video has been used in different ways for many years to support student learning in all branches of education (Shephard, 2003). It has a positive impact on student learning outcomes (Baharun & Porter, 2009) and upon students' perceptions regarding the enhancement of their learning motivation (Bravo et al, 2011).

Table 4.15 Student concerns about lectures, video and worked solutions

More resources: More worked solutions/answers to questions given in lectures (n=4); Extra resources; worked solutions; More video /audio working in the questions; Give more hints/video to help understanding the difficult questions; More video exploration through the lectures and worked examples; Relevant videos during lectures to keep concentration up; More details during the second half of the subjects.
Design of resources: More examples that are easy structured and accessible for revision; More step by step questions; More information to be included in the site; not enough step by step explanations; More step by step explanation/assumed knowledge was too large(2); Start with easy and then difficult; Improved resources e.g. materials needs to be explained more clearly; Further explanation; Get the base right first before moving into harder stuff.
Activities: Have more basic skills self tests; More exercise about formulas; Do more exercises in the lectures; More practical classes.
Access: All information for the course needs to be available in eLearning; Put all the work from the work book on eLearning; Put the assessments online in case people lose them; Put tutorial answers in eLearning.

Videos of worked examples, that is, examples supplying complete solutions that students can follow, have been found to engage students effectively (Patel & Feinson, 2005 & Otrel-Cass et al., 2012). Studying worked examples has been found to be much less cognitively demanding than problem solving teaching techniques, resulting in more efficient student learning (Belski, 2011).

4.3 Redesign 1

The feedback from students becomes part of the process of continuously improving the subject. Each implementation makes modifications: students review the subject and the reviews form the basis for further modifications. Student feedback led to several changes to the eLearning site. Specifically:

- Re-design of the online structure to provide better access to learning material;
- Outlining the assessment time table so as to clarify the assessments required;
- Adding resources, such as web links and videos to guide student learning;
- Adding a list of reference books available in the library covering each topic.

4.3.1 Redesign of online structures

The redesigned site (refer, Figure 4.22), included the same resources and tasks as the original site but involved major changes to the graphic portrayal of the home page and with minor modifications pages linked to that is the secondary level of pages. In the redesign there was a focus on resources, tasks and supports, and the temporal requirements associated with their use. Additional learning supports and resources were also provided.

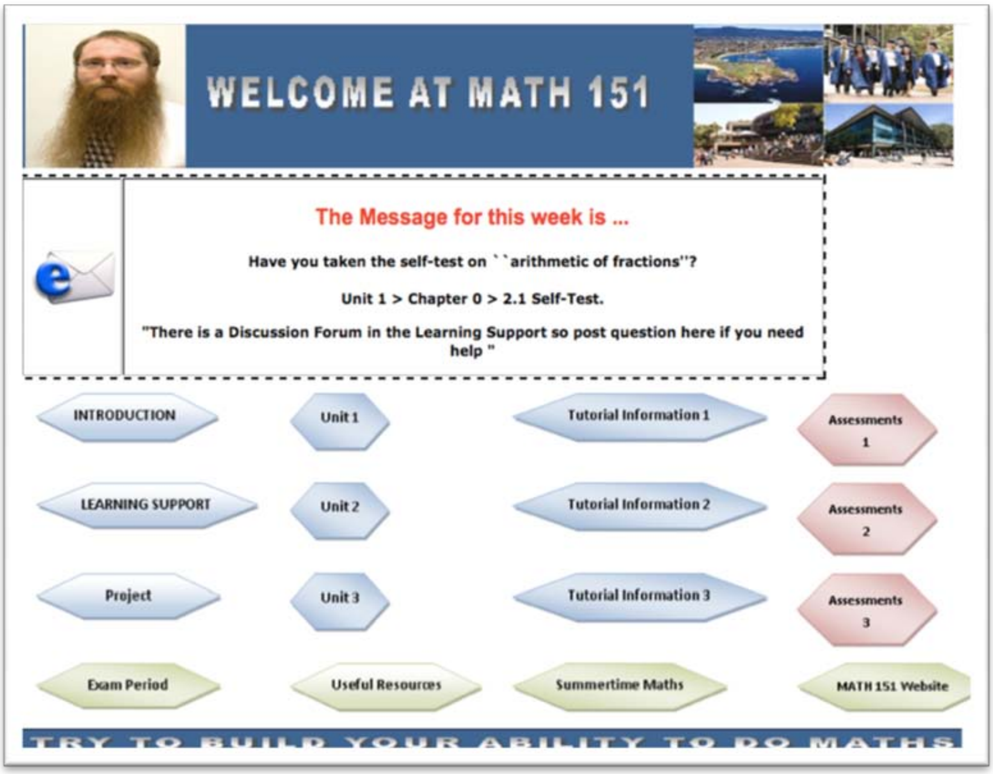


Figure 4.22 The redesign at the home page level

The redesign of the *home page* associated the tasks, assessment, tutorial and projects with the appropriate resources or units through position and provided a link to general support. Existing links to useful resources, past examination papers and solutions were included but repositioned. The location of the introduction link was moved to the first position reflecting the temporal order of requiring information.

The menu version provided to students is illustrated in Figure 4.23, with the "+" links opening to reveal other items. The *Useful resource, Summertime Math* and *MATH151 website* links remained the same except these were now created with similar icons, as was appropriate given they were all support resources.

Figure 4.23 Extract of home page by a menu, 2011

4.3.1.1 Introduction

The original folder on the eLearning site *Week 1 Information,* was replaced by an *Introduction* folder which included an overview video and assessment timetable. Other previous resources were given new names *subject outline* and *presentation* (refer, Figure 4.24).

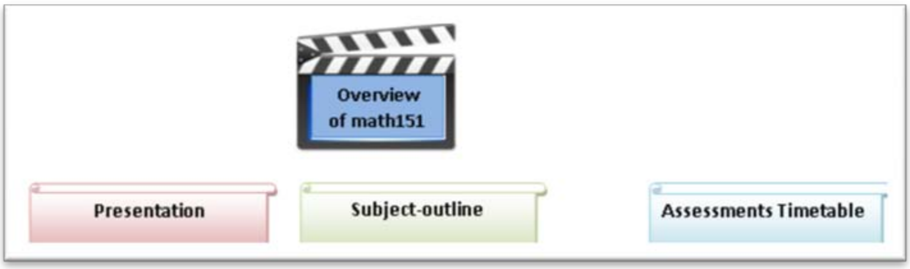


Figure 4.24 Second level page, Introduction

The *overview video* of the subject was created to provide an overall perspective on the subject and its requirements (refer, Figure 4.25).

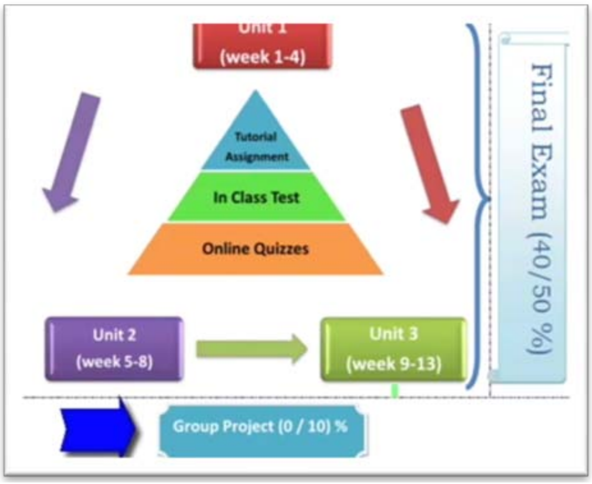


Figure 4.25 The subject requirements

The introduction page also provided students with an assessment timetable (refer, Table 4.16). The assessment schedule provided information available in the subject outline. Included were the learning outcomes that students are required to achieve and a separate icon provided the supports that could be used to help them achieve these outcomes.

Table 4.16 Assessment timetable

Weeks	In Class Test	Online Quizzes	Tutorial Assignment	Group Project	Final exam
Week 1					
Week 2			Tutorial Assignment (1) 3.3		
Week 3					
Week 4	(1) practical class Test paper 10%	(1)Multiple-choice From 8 am on Monday to 17:30 pm on Saturday			
Week 5					
Week 6	Repeat) In Tutorial class Test paper 10%		Tutorial Assignment (2) 3.3		
Week 7 -10	…pattern repeats				
Week 12	(3) Practical class Test paper 10%				
Week 13		(3) Multiple-choice From 8 am on Monday to 17:30 pm on Saturday		Presentation Group component 75 Individual component 2.5	
Exam Period					Final exam 50% or 40%
Total	30%	10%	10%	0 / 10%	50/or40%

4.3.1.2 Learning Support

In this subject learning supports are the strategies planned to facilitate learners experiencing difficulties to effectively achieve completion of the learning process. The home page was redesigned to include an icon for learning support. At the homepage level the previous link to the "questions about the course", a discussion forum where students and lecturer provided feedback or answered questions, was expanded to become a link to *Support* (refer, Figure 4.26).

These support folder linked to general forms of support: the *discussion forum*, the peer support program (*PASS group*), the consultation hours of the subject lecturers and contact details for a newly employed *maths support specialist*. The PASS study sessions for MATH 151 are facilitated by students who are regarded as high performers in the discipline (Van der Meer & Scott, 2009). Beginning in week 2 and run by an experienced senior student, students are helped to learn strategies and concepts. The PASS academic mentoring program will save students many hours struggling at home alone.

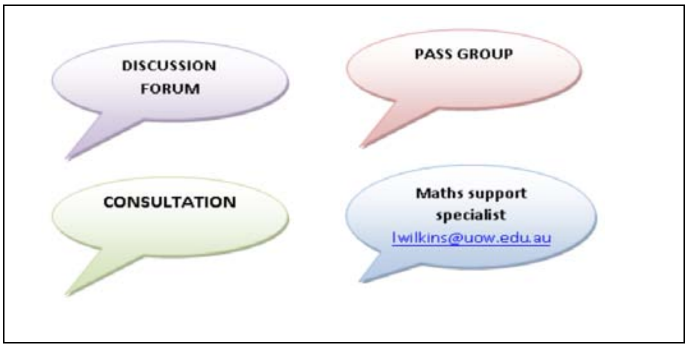


Figure 4.26 Learning support

On the learning support page there is a discussion forum where students can interact, talk to each other and the lecturer, ask questions, answer questions and check their understanding with lecturer and students. Access links to other support include consultation with the lecturer or consultation with a math support specialist from the Learning Development Centre, to locating a *PASS group* that allowed students with difficulties to gain assistance (Miller, Oldfield & Yvette, 2006).

4.3.1.3 Exam period

The Exam period page provided the same information as the old eLearning site but was represented by new icons and a name change from *The Revising for the Final Exam* to the *Exam Period* (refer, Figure 4.27). It contained sample exam papers with worked solutions.

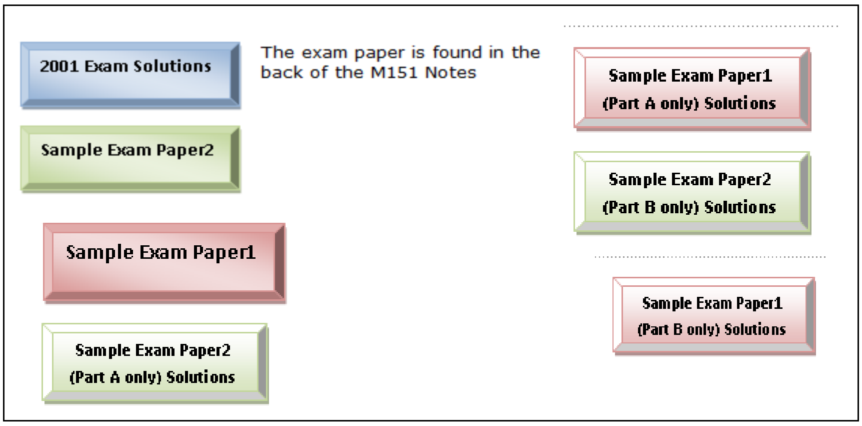


Figure 4.27 Exam period

4.3.1.4 Units 1- 3

All three units had the same design. Each unit, accessed from the home page commenced with an video overview of the unit, followed by one or more video overviews of each chapter (or part chapter) within the unit and the printed version of

the textbook chapter (refer, Figure 4.28). The positioning of the icons indicated the order in which the materials were to be accessed.

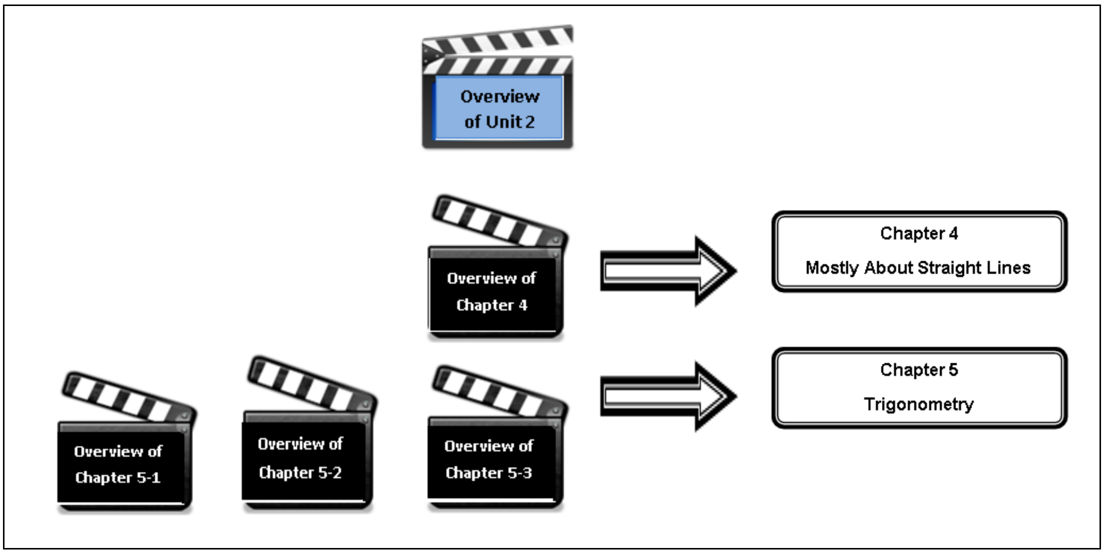


Figure 4.28 Unit 2 page

In the baseline period there were no orientation videos. In the redesign orientation videos were provided for Unit 1 and 2 (refer, Table 4.17). None were made available in the first redesign for Unit 3, simply due to the time required to produce them.

Table 4.17 Description of the orientation videos on eLearning

Topic in the textbook	Description of the orientation videos resources available
Unit 1 Review the content of unit 1 in term of the chapters that students will learn and explain about different kinds of assessment such as tutorial assessment, multiple choice quizzes and in class tests	
Chapter 0: Introduction	Revise some basic concepts of fractions, definitions of rational, integers and real numbers
Chapter 1 Introduction to Indices, Surds and Algebraic Fractions	Emphasis the topics indices and fractional surd expressions, algebraic fractions, and expanding expressions using Pascal's triangle. Factorize simple expressions.
Chapter 2 Logarithms	Focus on logarithms concepts which provide the foundations for chapters 6 and 7.
Chapter 3 Functions	Explains what a function is, 'Composing' functions, solving equations, what linear and quadratic functions are.
Unit 2 Review the content of unit 2 in term of the chapters that students will learn and explanation of different f assessments such as tutorial assessments, multiple choice quizzes and in-class tests	
Chapter 4 Mostly about straight lines	Overview of straight line and as used in chapter 7 data modelling. Identifies the conditions for lines to be parallel and perpendicular, solves systems of equations and how many solutions can be obtained from solving these equations
Chapter 5 Trigonometry	Overviews of basic trigonometry, radians and trigonometric functions y, solving equations, graphing functions and function applications

The main use of video was in introducing students to topics, (refer, Figure 4.29)

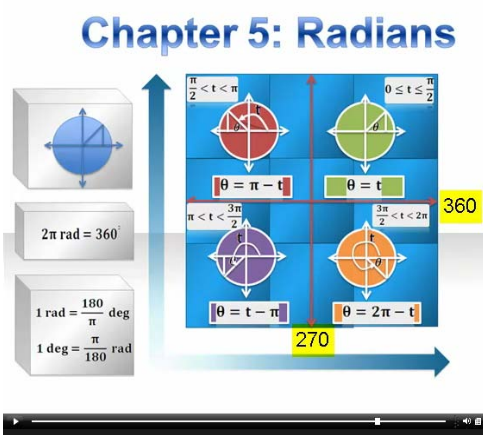


Figure 4.29 Theory overview

4.3.1.5 Tutorial Information

In the *Redesign 1* tutorial information folder included tutorial information. It had three links taking students to the learning activities that were aligned to learning outcomes and assessments for the three units, each of which was composed of several topics. These learning activities define, from a content perspective, what it is that students need to be able to do when they have learned the topic. The new design positioned the tutorial information, weekly tutorial and solutions (refer, Figure 4.30) into the relevant Tutorial Information page.

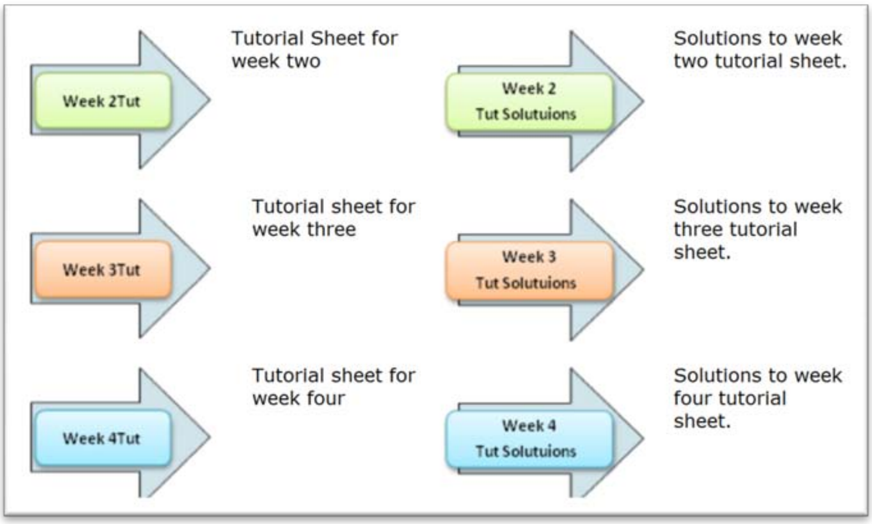


Figure 4.30 Tutorial information page for Unit 1

4.3.1.6 Assessment

The content of the *Assessments* folder linked to the baseline homepage was

repositioned and separated in the new design to three relevant *Assessment* pages. For example *Assessment 1* now included a practice online multiple choice quiz, practice examples, and an in-class test and assignment folder (refer, Figure 4.31)

Figure 4.31 Assessments for unit one

The page for the online multiple choice quiz provided a practice paper similar to the real one (refer, Figure 4.32). For Unit 1 the tests held in week 4 contained questions covering the first topics covered in chapters zero to two.

Figure 4.32 Multiple choice quiz

Similarly the in-class test folder (week four) contained two icons linking to a practice test and the solution (refer, Figure 4.33).

Figure 4.33 In-class test

The Assignment folder contains revision of student high school mathematics skills and worked solutions for the revision "assignment" (refer, Figure 4.34).

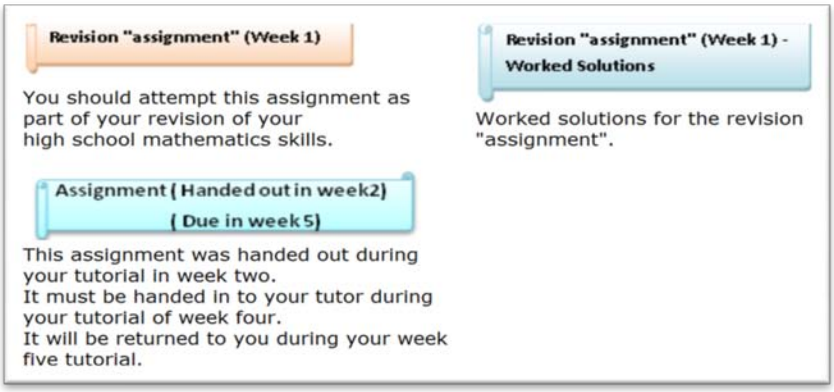


Figure 4.34 Assignment for *Unit 1*

The assignment was handed out during tutorial in week two. It was to be returned to the tutor during the tutorial of week four. It was to be returned to students during the tutorial in week five.

4.3.2 Outcomes Redesign 1

Results are examined from the perspective or what students said about the implementation after the first redesign through the *Change Evaluation*, and impact on outcomes as these data suggested changes in terms of Redesign 2.

4.3.2.1 Performance

As is evident in Table 4.18 there was no significant change in the proportion of students failing when comparing 2010 and 2011 results.

Table 4.18 Failure rate 2007-2011

Year	Enrolled	Fail * %	Mean	Standard deviation
2011	145	35.86	55	23.79
2010	128	35.94	54	21.3
2009	112	30.35	58	23.51
2008	97	26.8	59	21.7
2007	94	45.7	50	22.04

The failure rate for all years is defined as in 2012 when students previously awarded pass conceded be awarded a fail grade ie there will be a difference in rates when compared to previous tables.

It is reasonable to expect little change in failure rate after the first redesign as learning support resources had not yet been made available over the entire subject.

4.3.2.2 Perceived competency

An analysis of perceived student competency to undertake problems in a given topic area ranged from 37% for *Integration*, to 94% for *Algebra* (refer, Table 4.19).

Table 4.19 Perceived student competency

Topics	2010 Can do & Moderate Confidence		2011 Can do & Moderate Confidence	
	N=101	%	N=48	%
Algebra	85	85.9	44	93.6
Fraction	-	-	43	91.5
Indices	86	86	41	87.2
Trigonometry	84	84	37	78.7
Function Notation	79	79	36	76.6
Straight line	87	87	34	72.3
Logarithms	65	65	29	63
Differentiation	63	63	28	59.6
Exp. Growth & decay	50	50	23	48.9
Limits	51	51.5	22	46.8
Data Modelling	42	42.4	20	42.6
Integration	48	49	17	37

As for the baseline evaluation, the five lowest rated chapters are all from the second half of the subject and where new work is introduced. A chi-square test suggested no significant difference in students' perceived competency for any of the topics,

although eight of the eleven topics had a higher proportion of students responding with lower competency: a sign test indicated this was not significant (p=0.1797).

4.3.2.3 Valuing of offline resources

The feedback from students found that over all the resources at most 22% found the optional group project useful to at most 86% per cent of the students considered the lectures useful (refer, Table 4.20). Chi-square tests revealed no significant changes in the proportion of students finding the resources usefulness for any of the resources.

Table 4.20 Offline learning resources ranked in terms of usefulness

Learning Resources	2010 Total of extremely & moderately useful N=101		2011 Total of extremely & moderately useful N=48	
	N	%	N	%
Lectures	85	84.2	38	86.4
Assessments	83	83	32	71.1
Opportunity to undertake retest	-	-	43	97.7
Tutor in Practical class	82	82	32	71.1
Worked solutions	81	81.8	38	86.4
Work in Practical class	79	79	34	75.6
Textbook	78	78	37	82.2
Other work done in your own time	76	75.2	36	85.7
PASS	63	64.3	26	63.4
Consultation with lecturers	-	-	25	62.5
Group project	-	-	9	22

4.3.2.3.1 Textbook

One connecting thread through the evaluation was the lack of practice and worked examples available and the need to improve this aspect of the textbook. The analysis of the student comments regarding the textbook indicated that they wanted the textbook updated with more worked examples and with the relevance established (refer, Table 4.21).

Table 4.21 Student comments regarding the textbook

Lecture book: Update lecture book too busy; online lecture notes (PowerPoint) better; Improve book; more general science examples explained; concept first (give real example then tech it; can quizzes; Better lecture notes; better explanations; relevant explained; less bio / chemical example and more geology examples; More worked answers in book; Have the further examples at the end of the chapters put up in the e-learning with full worked solutions

Lectures: Clearer lectures notes Online lecture (2), lecture note available (2)

4.3.2.3.2 Assessment, marking and feedback

Comments in response to an open question (refer, Table 4.22) generated a request for changes to quizzes and assignments, additional resources, feedback, and a mark for every question. Students do have consultation hours available with lecturer but rarely

come but still comment they need more help. They are online quizzes for every topic suggesting that students do not see these in the eLearning site.

Table 4.22 Student concerns about assessment

Quizzes: No online quizzes; Longer time for online quizzes (2); not so hard assessment and more online quizzes; Take one way (multiple choice may be).
Assignments: Better assignment format; 5 test,2 assignment worth 30%; Make assignment worth more, they take a lot of time for little reward; The assessment and in class test and online quiz all being due in same week; Not having an assignment where not all answers are marked as it takes up too much time we could use to do other uni work; The assessments were quite difficult it would be beneficial if the lectures would advertise help for these; Did not like the assignment set up; online test were much better; A multiple choice section allows for more difficult question to be worked through backward so some understanding might be figured out without consultation immediately.
Resources: More online tests resources; Provide practice e-learning quizzes to show type of questions that will be tested; much more of the question or reduce number of unmarked questions; More revision of past test papers; More examples, online quizzes, worked answers in implementation.
Timetabling: 3 assessments in 1 week, thinking of practical classes.
Feedback: Working through questions after exams so mistakes are identified; Provide worked answers for tests.

4.3.2.3.3 Tutoring

Some students wanted better teaching in tutorials and better timetabling (refer, Table 4.23).

Table 4.23 Student concerns about tutoring

Tutorials: Tutorials have been useless; unprofessional tutorial; taught incorrect formulas; Better tute; I felt like I got no help from tute; complete waste of my time(2); shorter tute question with more emphasis on working out solutions; I think more face to face learning would help a lot more; Tutors go through solutions and show us how to do questions; Include tute notes so in case you miss out you are not completely scoured.
Timetabling: More tute time; No practical class, longer tutorial; Tute setup; Not enough time to do all question; 1 tute a week is not enough for a class of 15 as not all of us get our questions answered it way better; Practical class-pointless rather have a second tutorial. Lecture broken up so they are not so long late at night

4.3.2.4 Valuing of online learning resources

The change evaluation survey results indicated a range of responses when asked about the helpfulness of various online resources. Students found the existing online resources helpful in terms of understanding this subject. The lowest ranked resource, *Orientation videos resources* was found useful by only 59% of students while the highest ranked resource, found useful by 90% of students, was a primary resource provided weekly, *the tutorial solutions* (refer, Table 4.24). Chi-square tests indicated no significant differences in the proportion of students responding “extremely or moderately useful” between the two implementations for any one of the resources in the eLearning page. However, overall a sign test revealed that the students’ responses to the resources were significantly different to the previous year (p=0.0391) with

eight of the nine resources being more highly evaluated than previously.

Table 4.24 Usefulness of learning resources in eLearning homepage

Learning resources in eLearning homepage	2010 Extremely & moderately useful		2010 Extremely & moderately useful	
	N=101	%	N=48	%
Tutorial solutions	95	96.9	39	90.7
Worked examples	95	96.0	37	88.1
Assessment solutions	96	96.0	36	83.7
Sample test papers	94	94.9	41	95.3
eLearning Homepage	90	90.9	38	88.4
Self tests	87	88.8	36	85.7
Other additional resources	84	84.8	34	81
Forum eLearning page	77	78.6	21	51.2
Learning design map			-	-
Summer time math	77	78.6	31	73.8
Orientation videos resources			25	59.5

4.3.2.5 Attributes of eLearning

Students' comments indicated that the eLearning site was useful in helping them learn and understand. It was clear from the ranking of different features of the eLearning site, such as the clarity, structure and student comments, that it was better designed (refer, Table 4.25).

Table 4.25 The design of eLearning Pages

Gain from the design of eLearning Pages	2010 Total extremely & moderately useful		2011 Total extremely & moderately useful	
	N=101	%	N=48	%
Clear understand what have do and resource to help do task	-	-	40	97.6
Know what kind of support you have	-	-	40	97.6
eLearning better access material	80	80.8	41	97.6
Structure of eLearning page help understand objectives	74	74.7	41	97.6
Support through difficulties in learning	75	75.0	39	97.5
Structured to know required assessment	77	77.0	39	95.1
What the lecturer wants is clear	65	65.0	36	87.8

A high percentage of students finding eLearning site and its components useful revealed that components ranged in usefulness from 87% of students (*What the lecturer wants is clear*) to 97.6% for (*Clearly understand the task and the resource to help do* it.) Over all the five design components evaluated, the design in 2011 was better received than in 2010.

Student comments in response to the open-ended question asking "Is there anything done differently in your other subjects that could be used in this subject to make it

easy to learn?” indicated the subject was different to other subjects with MATH151 having a better design although there remained some criticisms (refer, Table 4.26).

Table 4.26 Student responses about online resources and navigation

Positive Comments: Very well organized easy to find things (2); Very good organized (3); Good layout; Very easy to navigate and user friendly; It is really different to my other subject; It is really math 151 better design; It’s all good. Can’t think of another subject that has a better e-learning website; This site is the better one (2); Best I have seen (2); Better than most; Very efficient; It is great work on this; Fantastic; It’s better customized; Much better with greater resources; Very different-clear, easy to see what part of course; Better in describing hyperlink for easier navigation of material; Bit different as other subject group lectures in one folder but this subject broken lectures up into section; Leave it how it is.

Need to improve: It’s really ugly; Uses interface which is not easy to navigate; Not very efficient log (2); Need better structure for 2nd half; Make it more interesting and user-friendly; A bit cramped, not very attractive; Make what is behind the link clearer; Interactive learning, really felt as though some staff did not care whether or not students were successful.

In the open-ended question students indicated that the number of videos available for the last five chapters was inadequate. Students requested extra worked solutions or links to resources (refer, Table 4.27).

Table 4.27 Students’ concern about resources

Resources: More website links and videos would be fantastic ; More visual video examples of concepts; More link available to understand math ; More worked examples and practice test; Every lecture should be put up on e-learning with full worked answers.

Types of resources: Having worked examples in the step by step (2) not step straight to an answers; Better worked examples of previous exams; more past exams available; some answers we were given were wrong; More working of examples during lectures that we are up to.

In response to the question “Do you have other suggestions to improve the subject?” it was clear that students wanted more resources for Unit 3, had issues with time, activities, lecture notes, relevance and timetabling (refer, Table 4.28).

Table 4.28 Other student suggestions

Lectures: Keep the first lecturer (5) Bigger writing, I could not make out values on board some times; The way the lectures are set out, projector is harder to read.

More for unit 3: More time in calculus; More practice examples for graph integration and diff and straight line (unit 3); Please put more resources online Summertime Math doesn’t help with unit 3; Have more help for unit 3 as there was not very much also but lecture slide and book answers for unit 3 up; More time on exp growth and decay, differentiation/integration. The latter were just too fast.

Too much or too little time: More time; Longer than 13 weeks; Maybe the one subject over full year option as well as the over a semester option; More time more explanation of key concepts; Don’t rush the last few lectures, integrals were done in about half an hour and are difficult; Module so maybe reduce content; We did not have time for half semester.

Activities: Four people for the group project is too many; Set homework sheet so we can better understand and keep the brain thinking when you don’t have a class and you are motivated because you have to do it.

Lecture Notes: Half decent course book, potentially a textbook. Also make the students engage in the class work; Lecture notes, basic examples, working up to harder examples.

Make applicable: Make this course applicable connecting to other subjects (focus on maths involved in other subjects, chemistry for example; More application towards how topics are used in science; More application to geology. There seems to only be chemical, bio, physics.

Timetable: Better lecture time 8:30 is ridiculous, spilt lectures up to four 1 hour lectures; No early morning lectures.

4.4 Re-design 2

In the second redesign of eLearning site no changes were made to the home page. The redesign was principally concerned with the redesign of second and third level folders. The second level folders for Tutorial information, the Assessments Unit and the learning support remained as for Redesign 1. The second level folders, Introduction, Unit 1 (adding the Head Start program) and Unit 3 (adding resources) were modified.

One of the advantages of keeping the structure the same for each unit highlighted to the designer when new supports or resources are required. For example, in this subject there were video resources for seven topics but not yet for the final three: data modelling, differentiation and integration. This was remedied in the second redesign. Following the redesign the action cycle was completed with implementation, change evaluation and final reflection on the changes evaluation in preparation for the next iteration.

4.4.1 Introduction folder

The *Introduction* folder was modified. Several links, *Overview of Math151*, *subject outline*, *presentation and the assessment timetable* remained the same as in the previous iteration except for changes to the icons (refer, Figure 4.35). Three new links were added: two information sources *Generic SMAS outline*, *Reference Books* and the third a link to a *Head Start program for students*. The *Generic SMAS outline* page documents the University and the School policies in relation to matters such as plagiarism and academic consideration, while *Reference books* provided a listing of a collection of useful books for this subject in the Library. The inclusion of the Head Start program was a substantive change to the subject.

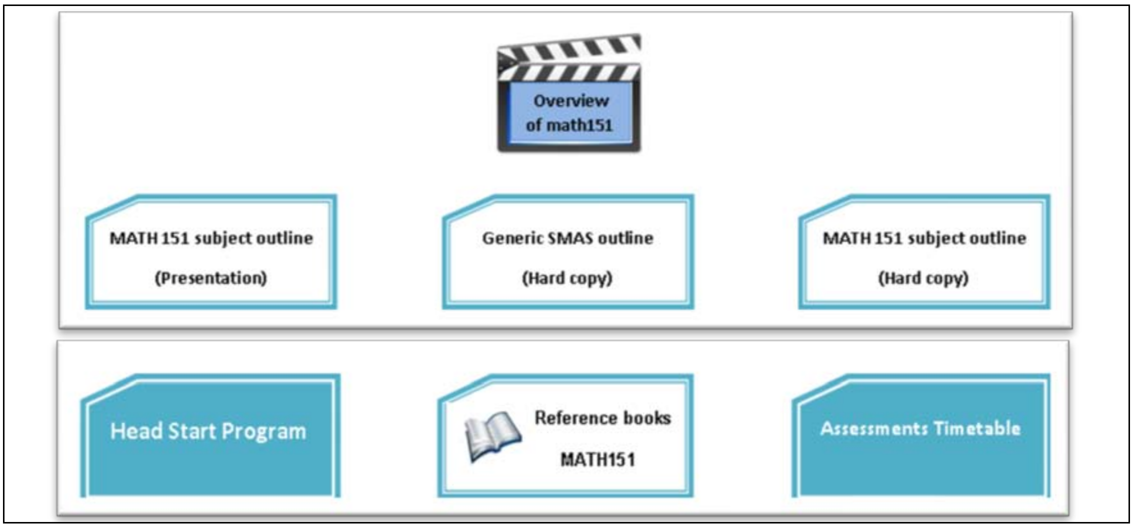


Figure 4.35 Redesign of the Introduction page

4.4.1.1 Head Start

The subject was modified to include a *Head Start* program and hence the eLearning site was modified so that the Introduction page included a link to *Head Start* program in 2012. The overview for the *Head Start* detailed the program, its benefits, and how students could use the program orientation video (refer, Figure 4.36) and its benefits

The link *Head Start* gives students access to a program which was based on a successful *Head Start* program run elsewhere in the School, STAT131, which had had success in reducing the failure rate (Baharun, 2012). The *Head Start* program caters for students with weak mathematical skills, students who want to improve their skills or simply students who would like to start the subject ahead of time. It was thought that the program could address, in part at least, time issues raised by the students as the program gives them an opportunity to commence study for MATH151 two weeks before session starts using a range of learning resources and learning support made available, via the MATH151 eLearning site. It also allows them to review and consolidate the foundations of the subject before starting new topics, in addition to immersing them in a learning environment that should help them achieve their goals and pass the subject.

Students enrolled in MATH151 are notified by email as to the availability of the *Head Start* program. Instructions are provided to students regarding use of the online *Head Start* program (refer, Figure 4.36).

What is the Head Start Program?

The Head Start Program gives you an opportunity to commence MATH151before session starts. With a range of learning resources and learning support available, the Head Start program allows you to study via the MATH151 eLearning site from anywhere and at any time.

What are the benefits of the Head Start Program?

The Head Start Program allows you to:

- Commence the first unit in MATH151before the start of session
- Review and consolidate the foundations of the subject before starting new topics
- Immerse yourself in a learning environment which will help you in achieve your goals and pass the subject.
- Students taking MATH151are given an assignment in week two. Students on the Head Start Program are given an opportunity to complete an alternative assignment. If you complete this assignment then you need to complete the week two assignment part B. This gives you an extra time to review this subject.

How do I use the Head Start Program?

To use the Head Start Program

- Work your way through the Head Start material associated with each of the chapters in the first unit of MATH151 (chapters 0-3)
- Work through the Head-Start program in conjunction with reading the MATH151 textbook, which is available from the UOW book shop.(if you want to work your way through the Head Start Program and you do not yet have a copy of the textbook that is OK)

Figure 4.36 Head Start information

4.4.2 Unit 1

In Unit 1, the third level chapter folders, *Chapter 0: Introduction*, Chapter 1: *Indices, Surds & Algebraic Fraction*, *Chapter 2: Logarithms* and Chapter 4: *Straight line* were modified in response to the introduction of the *Head Start* program. The menu, for example to Chapter 2: *Logarithms*, (refer Figure 4.37), links students to the *Summertime Math* resources for those topics.

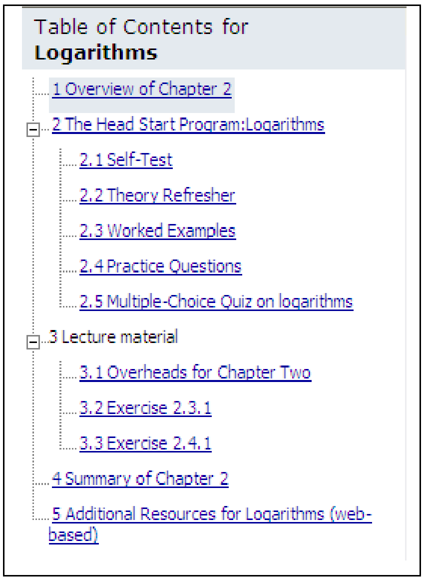
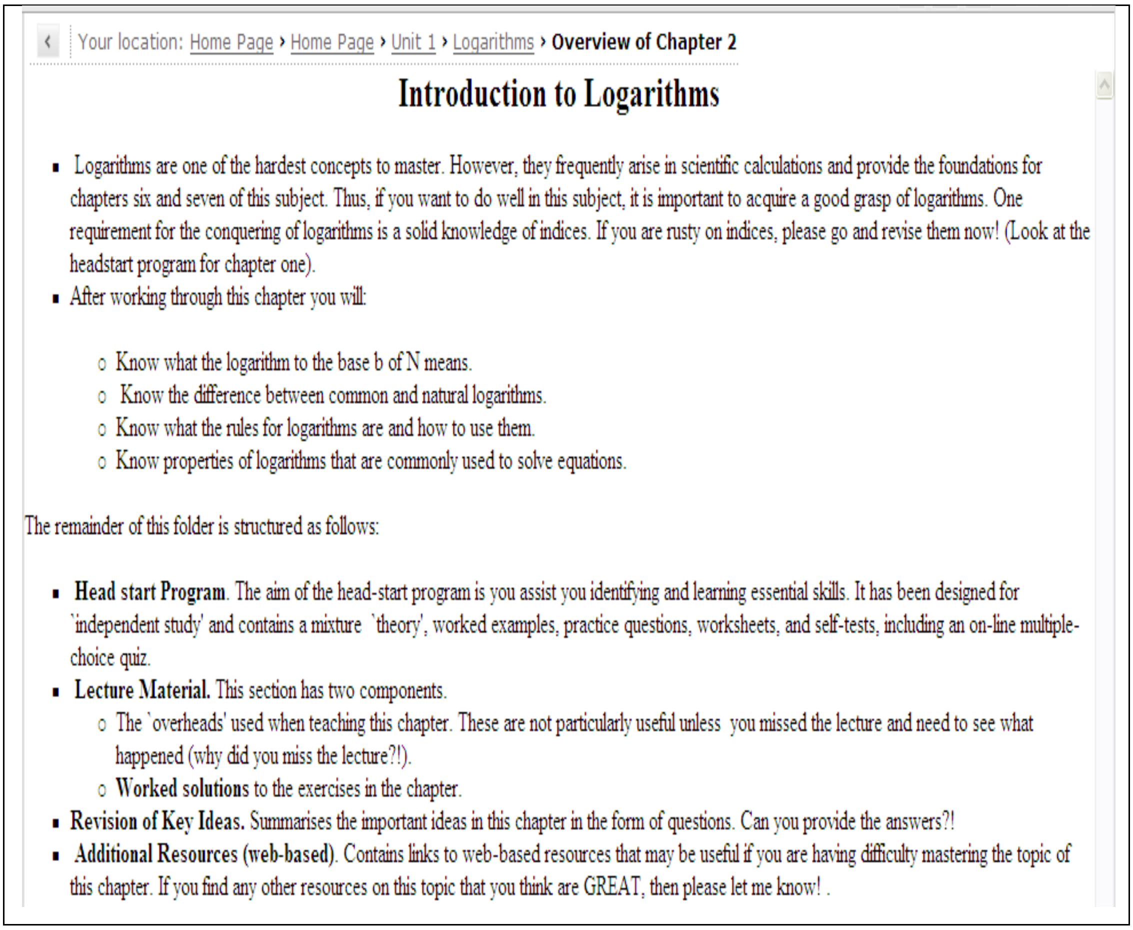


Figure 4.37 Chapter 2, Logarithms, reference to the Head Start program

Each of the four chapters links commenced with an *Overview*, which addressed learning issues, for example “this is the most difficult topic”, commenting regarding relevance, “frequently arise in scientific calculations” and their pre-requisite

function, “provide the foundations for Chapters 6 and 7”. The learning outcomes, in terms of what students will be able to do are identified, along with information. Taking advantage of the online features, *The Head Start Program Logarithms*, links students directly the *Summertime Math* resources including self-tests, theory refreshers, worked examples, practice examples and additional web-based learning resources, (refer, Figures 4.38).



Your location: Home Page › Home Page › Unit 1 › Logarithms › **Overview of Chapter 2**

Introduction to Logarithms

- Logarithms are one of the hardest concepts to master. However, they frequently arise in scientific calculations and provide the foundations for chapters six and seven of this subject. Thus, if you want to do well in this subject, it is important to acquire a good grasp of logarithms. One requirement for the conquering of logarithms is a solid knowledge of indices. If you are rusty on indices, please go and revise them now! (Look at the headstart program for chapter one).
- After working through this chapter you will:
  - Know what the logarithm to the base b of N means.
  - Know the difference between common and natural logarithms.
  - Know what the rules for logarithms are and how to use them.
  - Know properties of logarithms that are commonly used to solve equations.

The remainder of this folder is structured as follows:

- **Head start Program**. The aim of the head-start program is you assist you identifying and learning essential skills. It has been designed for 'independent study' and contains a mixture 'theory', worked examples, practice questions, worksheets, and self-tests, including an on-line multiple-choice quiz.
- **Lecture Material.** This section has two components.
  - The 'overheads' used when teaching this chapter. These are not particularly useful unless you missed the lecture and need to see what happened (why did you miss the lecture?!).
  - **Worked solutions** to the exercises in the chapter.
- **Revision of Key Ideas.** Summarises the important ideas in this chapter in the form of questions. Can you provide the answers?!
- **Additional Resources (web-based)**. Contains links to web-based resources that may be useful if you are having difficulty mastering the topic of this chapter. If you find any other resources on this topic that you think are GREAT, then please let me know! .

Figure 4.38 Chapter 2 Logarithms

4.4.3 Unit 3

The *Unit 3* folder was completed in accordance with the design for Units 1 and 2 in *Redesign 1* with *Overview of Unit*, and *Overview of Chapter* videos and each of the chapters were added to Unit 3 (refer, Figure 4.39).

For *Chapter 8: Limits* a Learning Design Visual Sequence (LDVS) was used as an alternative approach to map the resources (with orientation videos and worked example videos), activities (tutorial information sheet and Limit work sheet), and supports (self-tests, tutorial information solution, limit worked solution). The purpose was to explore an alternative design approach.

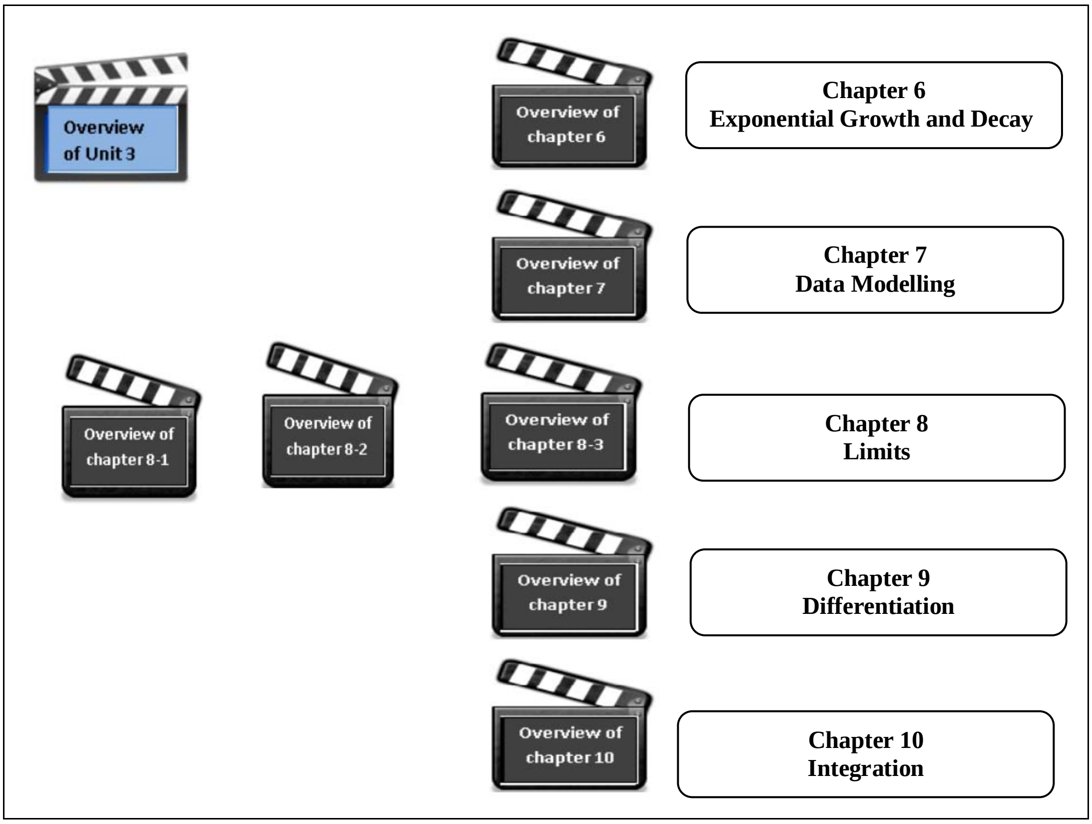


Figure 4.39 Unit 3

4.4.3.1 Resources: *Overview of Unit*

The orientation video, *Overview of Unit 3*, focused on identifying the chapter topics and explained the nature of the three types of assessments: multiple choice quizzes, in-class tests and tutorial assessment for the unit, building to the summary image (refer, Figure 4.40).

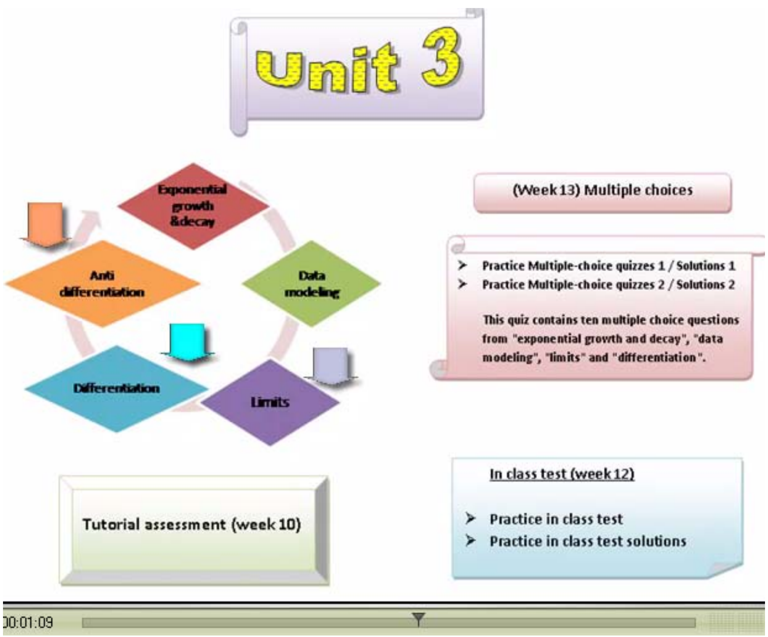


Figure 4.40 Unit 3 overview

4.4.3.2 Resources: Overview of Chapter

The second major change in the Unit 3 folder was the addition of seven more video resources as a response to student concerns regarding lack of resources for Unit 3. These videos provided orientations to the five chapters, or half chapters (refer, Figure 4.41).

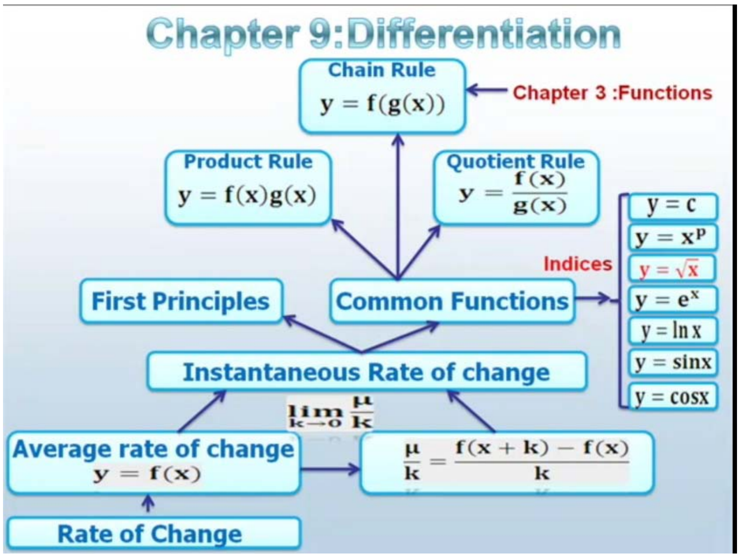


Figure 4.41 Unit 3, Summary image

These were designed in a similar manner to the *Overview of Unit 3* video, to show the sub-topics or key ideas covered and their linkages to other chapters (refer, Table 4.29).

Table 4.29 Description of the orientation videos available on eLearning

Topic in the textbook	Description of the orientation videos resources available
Unit 3 Review the content of unit 3 in term of the chapters that students will learn and explained about different kinds of assessment such as tutorial assessments, multiple choice quizzes and in-class tests	
Chapter 6 Exponential Growth and Decay	Demonstrates the use of mathematics with science application; how to sketch functions, for example, exponential growth and decay, biological growth, radioactive decay and logistic growth.
Chapter 7 Data Modelling	Relates logarithm and straight line chapters to data modelling. Demonstrates how to represent straight line data graphically, introduces exponential and power functions
Chapter 8 Limits	The topic orientation was divided into three videos starting with the meaning of limits and followed by finite limits and infinite limits.
Chapter 9 Differentiation	Explains the instantaneous rate of change with differentiation, common function and product and quotient rules and the chain rule.
Chapter 10 Integration	Introduces two kinds of integration: indefinite integrals and definite integrals, how these are solved and their application.

4.4.3.3 Resources: Worked Examples

The second set of videos, accessed through video resources comprised twenty-nine worked examples to complete the provision of videos over all topics. These worked examples (refer, Table 4.30), included nine worked examples for the limits chapter,

twelve worked examples for differentiation (refer, Figure 4.42), and eight worked examples for the integration chapters. Additional videos could have been created on other aspects of these topics for example Data Modelling.

Table 4.30 Description of worked example videos resources

Topic in the textbook	Description of worked example videos resources available
Unit 3 Reviews the content of Unit 3 in term of the chapters that students will learn and explains the different kinds of assessment such as tutorial assessment, multiple choice quizzes and in class tests	
Chapter 8 limits	• Example of graphic reciprocal function of y= f(x) • Limiting values as of a function • Examples of finite limits of a function • Examples of infinite limits of a function, part-1 • Further examples of infinite limits of a function, part-2 • Further examples of infinite limits of a function, part-3 • Example of the limit of a function that does not exist • Limit examples of a function by using rationalisation • Examples of limits for an exponential function
Chapter 9 Differentiation	• Average rate of change of a function • Differentiation – limit of the average rate of change of a function for y=f(x) • Differentiation – slope of a tangent line of y=f(x) • Example of differentiation using limit of the average rate of change • Differentiation patterns for polynomials • Simple example of differentiation of a polynomials • Differentiation rules, part -1 (Power/ Linear combination) • Differentiation rules, part- 2 (Product Rule/ Quotient Rule) • Differentiation rules, part 3 (Chain Rule) • Differentiation rules, part-4 (Trig/Exponential / Log function) • Further example of Differentiation (Trig/Exponential / Log function) • Geometrics example using differentiation
Chapter 10 Integration	• Anti-differentiation rules- patterns matching examples • Integration rule, and example part -1 • Integration rule, and example part -2 • Integration rule, and example part -3 • Integration rule, and example part -4 • Definite integral example-1 • Definite integral example-2

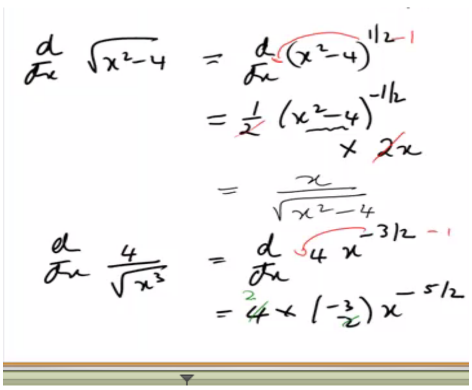


Figure 4.42 Worked examples for differentiation

4.4.3.4 Learning Design Visual Sequence (LDVS)

Chapter 8: Limits was designed in accord with the learning design visual sequence (Agostinho, 2009), showing the structure of the educational process to allow students to better understand the learning and teaching process. For this chapter, the learning design was seen as a model that more explicitly communicates to students the structure of the lecturer's plan for the delivery of educational processes such as tasks, supports, resources and timing. In this implementation the learning design includes a structural plan for each level of the education process; the subject, the sub-unit or chapters, mapping the activities, the assessment and the support.

Using the Learning Design Visual Sequence (LDVS) model (Oliver, 2001; Oliver & Herrington, 2001) students are provided a map of the resources, activities and supports for use when completing topics. This map aligns topic names and learning resources such as videos, tutorial assessments, practice test examples and in class tests. The timing of work is also conveyed (refer, Figure 4.43).

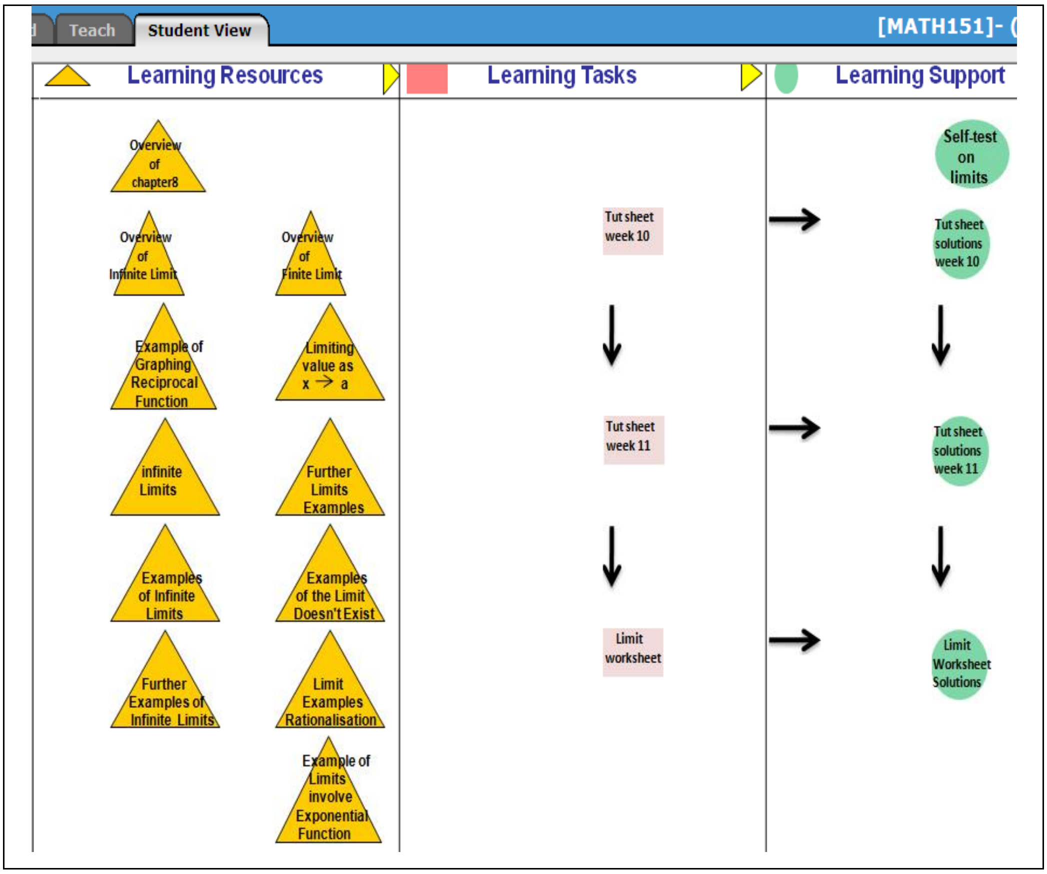


Figure 4.43 LDVS based learning design map for the chapter, Limits.

Even though the structure of eLearning site is different for this chapter, it still uses the same idea of connecting resources, activities and the support. Ideally the mapping

process should provide a holistic overview, as suggested in the Learning Design Visual Sequence (LDVS). This suggests that the tutorials, assessments and additional resources, provided as separate links/pages in the first re-design should be included holistically in a LDVS map. While the first redesign moved the eLearning page structure closer to the LDVS it did not associate each task or class of tasks to specific support and resources. To obtain such a map involves skills such as the use of image maps, icon creation, and PDF creation from Math type programs. The implementation of the map is far more time-consuming then simply uploading content. Further, many aspects of design are subject to debate and perhaps personal preference. For example, the lecturer gave higher priority to the ease of being able to place assessment components into the website over the desire to include them in a holistic map which would need to be revised every time the components were changed. Students sometimes also prefer the single location for all assessment tasks reflecting their different learning styles.

4.4.4 Outcomes Redesign 2

Results are examined from the perspective of the students: from what they said about the implementation in the *Change Evaluation* after the second redesign; their performance both in MATH151 and as a consequence of the *Head Start* program and the impact on outcomes as this suggested changes in terms of Redesign 2.

4.4.4.1 Performance

Although a significant amount of time and effort has been devoted to MATH151 to improve the learning resources that are available to students, and despite students indicating they have increased the work they do in this subject, the failure rate in this subject has remained above 30% and this is too high (refer, Table 4.31).

Table 4.31 Failure rate 2010-2012

Year	% Fail *	Mean	Standard deviation	Enrolled
2012	33.6	52	22.97	119
2011	35.86	55	23.79	145
2010	35.94	54	21.3	128
2009	30.35	58	23.51	112
2008	26.8	59	21.7	97
2007	45.7	50	22.04	94

* The Failure rate for all years is defined as in 2012 when students previously awarded pass conceded be awarded a fail grade ie there will be a difference in rates when compared to previous tables.

The lecturer suggested that students failed because of their poor skills and further that there is a high proportion of students with poor skills. In 2012 only 36% of students passed the *Week 4 Basic Skill*s Test (refer, Table 4.32).

Table 4.32 Subject failure rate by grade in the Week 4 Basic Skills Test

Year	Students	Mark (0.0-4.0)		Mark (4.5-10.0)		Mark (10.5-20.0)		% students Sitting the test
	N	N	%	N	%	N	%	
2012	111	16	14.4	55	49.6	40	36.0	93.3
2011	130	10	7.7	48	36.9	72	55.4	89.7
2010	117	9	7.7	53	45.3	55	47.0	91.4
2009	102	15	14.7	46	45.1	41	40.2	91.1

* For the purposes of this table a Pass Conceded (2009-2011) is considered a fail. Students who did not attend the *Week 4, Baseline Skills test* are excluded from the pass/fail percentages.

Those who receive a *Basic Skills Test* mark in Week 4 of between 0 and 4 have a high failure rate, 63% failing in 2012 whereas only 5% of students who passed the *Basic Skills Test* failed the subject overall. Reports made by the lecturer suggested a relationship existed between the *Week 4 Baseline Skills* test scores and whether students pass or fail the subject (refer, Table 4.33).

Table 4.33 Subject failure rate by grade in the Week 4 Basic Skills Test

Year	Mark (0.0-4.0)			Mark (4.5-10.0)			Mark (10.5-20.0)		
	Passed	Failed	Fail %	Passed	Failed	Fail %	Passed	Failed	Fail %
2012	6	10	63%	35	20	36%	38	2	5%
2011	1	9	90%	25	23	48%	63	9	13%
2010	0	9	100%	28	25	47%	50	5	9%
2009	4	11	73%	28	18	39%	40	1	2%

Combining the “0-4.5” and “4.5-10” marks (refer, Table 4.34), to satisfy the assumption of a minimum expected count of five for a chi-square analysis, data supplied by the lecturer shows that performance on the week four *Basic Skills Test* was significantly different over the years 2009 to 2012 (χ^2=10.392, df=3, p=0.016). Performance was extremely poor for 2009, with 40.19% passing, poor for 2010 with 47% of the students passing, and 2011 with 55.38% passing, and poorest in 2012, with only 36% of students passing the *Week 4, Basic Skills Test*, In 2009 and 2012, there is a drop in student quality with the percentage of students with the 0-4 mark higher than in other years.

Table 4.34 Combine of the “0-4.5” and “4.5-10” marks

Years	Mark(0-10)		Mark(10.5-20.0)		Total
	N	%	N	%	N
2012	71	64.0	40	36.0	111
2011	58	44.6	72	55.4	130
2010	62	53.0	55	47.0	117
2009	61	59.8	41	40.2	102
Total	252		207		459

As shown by a chi-square analysis students with poor baseline skills (marks 0-10) they have a significantly different and higher failure rate than students who pass the *Week 4, Baseline Skills test* in 2009 (χ^2=24.024, df=1, p<.0005), in 2010 (χ^2=27.449, df=1, p<.0005), 2011(χ^2=27.091, df=1, p<.0005), and 2012 *(*χ^2=17.306, df=1, p<.0005) (refer, table 4.35).

Table 4.35 Grades associated with Week 4 Basic Skills marks

Year	Mark(0-10)				Mark(10.5-20)				Total			
	Passed	%	Failed	%	Passed	%	Failed	%	Passed	%	Failed	%
2012	41	36.9	30	27.0	38	34.2	2	1.8	79	71.2	32	28.8
2011	26	20	32	24.6	63	48.5	9	6.9	89	68.5	41	31.5
2010	28	23.9	34	29.1	50	42.7	5	4.3	78	66.7	39	33.3
2009	32	31.4	29	28.4	40	39.2	1	1.0	72	70.6	30	29.4

The lecturer believes that even very weak students are able to pass MATH151 if they are willing to put in the hours to overcome their difficulties with mathematics. The lecturer recollected a case where students scored 2/20 on *Week 4, Baseline Skills test*. This student worked very hard and making full use of all resources that had been developed in addition to consulting with the subject co-ordinator on a weekly basis. The student completed the subject with a well-earned mark of 50%. “How to engage all students in such work?” remains as an important question.

If the ability of students is, lower in the implementation cohort than it was in the baseline cohort it would be reasonable to expect the failure rate to increase in the implementation group. In this instance the baseline ability of students was lower for the implementation cohort and the failure rate remained the same. As the failure rate did not increase as expected given the lower ability of the students, it could be interpreted as the subject and site changes and in particular the additional resources, are useful for students.

4.4.4.2 Head Start Outcomes

In 2012 the *Head Start* MATH151 program was offered to all 119 enrolled students. It was available two weeks prior to session in 2012, with students notified by email, as to its existence. Twenty-two per cent of students (n=26) engaged with the program. Failure rates (Fail and pass conceded) overall dropped 2% from 35.6% in 2011 to 33.6% 2012, although statistically this is not a significant difference. An analysis of the student comments regarding the Head Start indicated that it was useful. Students wanted all topics covered although a sizable number did not know

about it (refer, Table 4.36) suggesting a design or procedural issue in terms of advertising.

Table 4.36 Student comments regarding the Head Start

Useful: They did not do *Head Start* but it could be useful (2); *Head Start* very helpful (2)
Head Start was very useful in helping with math skill ; *Head Start* very useful and would be more beneficial if it covered all topics with more worked examples; *Head Start* is great and I loved the option.
The *Head Start* would be advantageous; *Head Start* was excellent; The layout of *Head Start* is better. There should be more harder questions and layout of answers such as trig function.
Advertising availability: I did not know about or was unaware of *Head Start* (8); I could not access the *Head Start* program; I did not use the *Head Start* program.

A comparison of the structure of the *Head Start* program and the program upon which it was modelled revealed three key differences:

- The *Head Start* in MATH151 was available only for two weeks prior to the start of the 13 week teaching session rather than 3 weeks for the modelled program;
- The model program provided assessment for students to complete prior to the start of session;
- An alternative program was implemented in the incorporating some of the in-session resources but for the most part using complementary resources.

One outcome has been that the lecturer identified changes to the *Head Start* program for implementation in 2013. The MATH151 *Head Start* program was redesigned in 2013 to allow more time, design assignment and initiating a fourth cycle of change (refer, Figure 4.44).

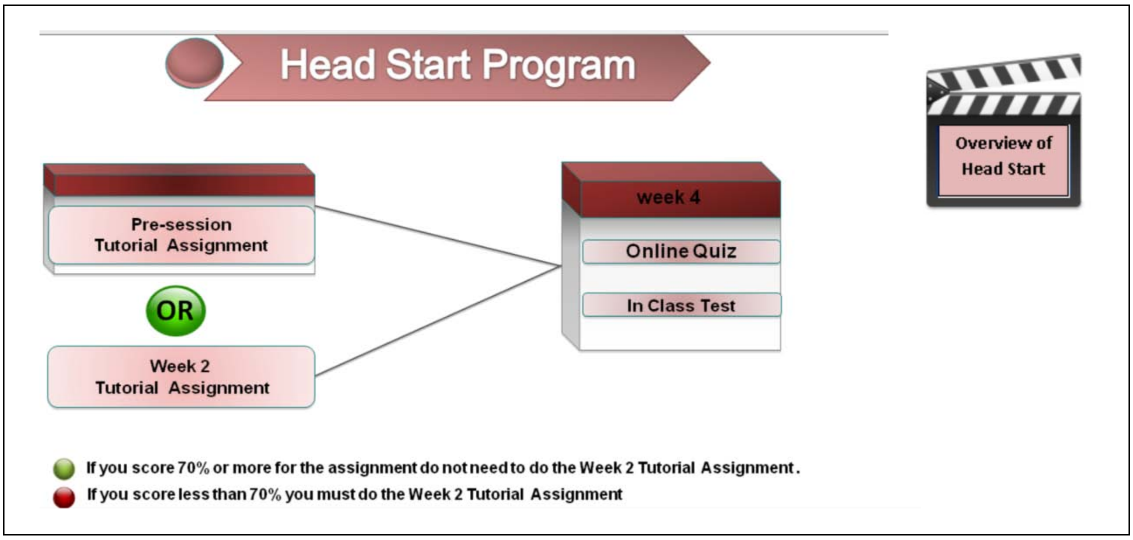


Figure 4.44 Assessments

Students are able to work their way through the resources associated with each of the chapters 0 to 3, accessed through the first unit of MATH151. Working through the

chapters and video clips they prepare themselves to complete an early assessment. By week 2, students will be able to complete and gain feedback on an alternative version (Part A) of an assignment that is otherwise due in week 4. If students satisfactorily complete this *Head Start* alternative assignment with a mark of 70% or more then they need to complete only Part B of the assignment due in week 4. They can complete all of the assignment due in week 4 if they wish to improve their marks. The *Head Start* gives students extra time to review the subject, although it does not provide alternative resources.

4.4.4.3 Perceived competency

An analysis of perceived student competency to undertake problems in a given topic area ranged from 26.9% for *Integration*, to 90% for *Fractions* (refer, Table 4.35). The five chapters rated lowest, as for earlier implementations, are all from the second half of the subject. Chi-square analysis with year (2010-2012) and perceived student competency ("Can do" versus "Cannot do") and for 2011-2012 shows no significant difference in student perceived competency in their ability to solve problems for any topic areas for the three different implementations before and after redesign (refer, Table 4.37, 4.38). That the students express the same sense of competency with previous year students, when the 2011 and 2010 students had better Week 4 Baseline Skills suggests that learning resources are supporting students learning.

Table 4.37 Perceived student competency

Topics	2010 Can do & Moderate Confidence		2011 Can do & Moderate Confidence		2012 Can do & Moderate Confidence	
	N=101	%	N=48	%	N=61	%
Straight line	87	87	34	72.3	45	75
Indices	86	86	41	87.2	51	83.6
Algebra	85	85.9	44	93.6	51	83.6
Trigonometry	84	84	37	78.7	39	63.9
Function Notation	79	79	36	76.6	45	75
Logarithms	65	65	29	63	39	63.9
Differentiation	63	63	28	59.6	32	52.5
Limits	51	51.5	22	46.8	34	55.7
Exp. Growth & decay	50	50	23	48.9	28	45.9
Integration	48	49	17	37	14	26.9
Data Modelling	42	42.4	20	42.6	23	38.3
Fraction	-	-	43	91.5	54	90

Table 4.38 Chi-square perceived student competency

Topics	Chi-square 2010-2011		Chi-square 2011-2012	
	χ^2	P	χ^2	P
Straight line	4.720	.030	.096	.756
Indices	.041	.839	.277	.599
Algebra	1.865	.172	2.512	.113
Trigonometry	.611	.434	2.785	.095
Function Notation	.109	.742	.036	.849
Logarithms	.053	.819	.009	.924
Differentiation	.159	.690	.544	.461
Limits	.282	.595	.848	.357
Exp. Growth & decay	.014	.904	.098	.754
Integration	1.827	.176	1.136	.286
Data Modelling	.000	.988	.195	.659
Fractions	-	-	.069	.793

4.4.4.4 Valuing of offline resources

When comparing the numbers of students who found offline resources useful with those who didn't, chi-square analyses of feedback (refer, Table 4.39) revealed only two significant differences in the valuing of any resources over the three years (refer, Table 4.40). From 2011 to 2012 there was significant decline in the valuing of *consultation with lecturers* that suggests that students had less need to consult the lecturer since there was no change to the availability of the lecturer. This could be interpreted that the resources which are known to be complete are being more useful, or, perhaps as suggested by the lecturer, that there is a change in attitude regarding students and seeking help through consultation. There was also a decline in usefulness and *other work done in your own time.*

Table 4.39 Learning resources ranked in terms of usefulness

No Learning Resources	2010 extremely & moderately useful		2011 extremely & moderately useful		2012 extremely & moderately useful	
	N=101	%	N=48	%	N=61	%
Lectures	85	84.2	38	86.4	46	76.7
Assessments	83	83	32	71.1	43	71.7
Opportunity to undertake retest	-	-	43	97.7	56	93.3
Tutor in Practical class	82	82	32	71.1	47	78.3
Worked solutions	81	81.8	38	86.4	53	88.3
Work in Practical class	79	79	34	75.6	41	68.3
Lecture Handbook	78	78	37	82.2	43	72.9
Other work done in your own time *	76	75.2	36	85.7	37	63.8
PASS	63	64.3	26	63.4	43	74.1
Consultation with lecturers *	-	-	25	62.5	20	35.7
Group project	-	-	9	22	16	29.6

Table 4.40 Chi-square Learning resources ranked in terms of usefulness

Learning Resources	Chi-square 2010-2011		Chi-square 2011-2012	
	χ^2	P	χ^2	P
Lectures	.116	.734	1.537	.215
Assessments	2.673	.102	.004	.950
Opportunity to undertake retest	-	-	1.071	.301
Tutor in Practical class	2.189	.139	.720	.396
Worked solutions	.451	.502	.090	.764
Work in Practical class	.214	.644	.657	.418
Lecture Handbook	.337	.561	1.255	.263
Other work done in your own time	1.914	.167	5.939	.015
PASS	.010	.922	1.308	.253
Consultation with lecturers	-	-	6.723	.010
Group project	-	-	.709	.400

4.4.4.4.1 Work in Own Time

While students perceived the benefits of work in their own time, one of the positive outcomes is that students over the three implementations have increased the time they spent working on the subject. As is evident over the three implementations the number of students spending less than six hours per week on learning MATH151 has roughly halved each year from 50.5% in the baseline period to 25.0% in *Redesign 1* to 13% for *Redesign 2*. However the advised time for the average student to complete this subject is twelve hours per week (The twelve hours per week include five hours contact time and seven hours out of class time). Time constraints limit the amount of time students have, however, it would appear by their own admission, that a large percentage (77% to 86.1%) spent eight hours or less, less than required time (refer, Table 4.41) and this is possibly a major reason for the high failure. Students do appear more engaged more fully with the subject at least in terms of time spent.

Table 4.41 Average time spent on MATH151 per week

hours per week	Years						Total	
	2010		2011		2012			
	N	%	N	%	N	%	N	%
Less than 6	51	50.5	12	25.0	8	13.1	71	33.8
6-8	36	35.6	23	47.9	39	63.9	98	46.7
9 or more	14	13.9	13	27.1	14	23.0	41	19.5
Total	101	100	48	100	61	100	210	100

Chi-square 2010-2011(x^2 =9.379, p=.009)
Chi-square 2011-2012(x^2 = 3.465, p=.177)

4.4.4.4.2 Lecture delivery

In response to the open ended question students suggested that lectures need improvement in terms of the delivery of the subject, with suggestions that PowerPoint be used, and delivery improved with more revision (refer, Table 4.42).

Table 4.42 Student comments on lectures

Better explanation: Show step by step how to answer; Lecturer should explain, worked examples then practice exercise; More worked example in step by step on how to solve the questions; More explained in the lecture materials step by step process; Lectures could be improved by explaining things in more ways and doing more examples; Working out of questions to show how to do them would be good; More direct lecturer's outline and clearer understanding as to what needs to be; Smoother progression between subject
Revision: Have more time spent on the last few weeks of the course content; Revision lectures are needed; Revision lecture before test/ assignments; Have retest for the 3rd in-class test
Delivery: Need good delivery; Lecture needs to be explained; Try to make lectures more interesting; Better explanation of math aspect; Get straight to the point in lectures; Use better technology to present material and no more project slide; The way the lectures are delivered is very boring; The hand writing of the lecturer made the examples difficult to read; Lectures should go for one hour and more often; Audio recording for lecturer is needed in eLearning (3); Lectures communication and structures
Use PowerPoint: Lecturers should use PowerPoint (3); PowerPoint presentation could b employed more frequently; Lectures should use slide show; Need PowerPoint slide for lecturer delivery; Using the old projector slides is hard to read & messy and slower presentation needs to be improved; Need presentation type of learning; One first lecturer for all; Keep the first lecturer.

4.4.4.4.3 Assessment, marking and feedback

Student suggested improvements included: provision of information about tests, the need for more worked solutions of self-tests, (refer, Table 4.43).

Table 4.43 Students concerns about assessment

Assignments: Ensure that assessments are sign posted (1); Clear information of assignment and test dates folder for each subject topic (1); Don't give out assignments that can't be returned before maths test. There is no way to know that you are doing the question wrong with sufficient time before test; Less assignments (2) and tute (1); More examples how to do assignments; Assignments, exam quizzes should not all be in the one week (2).
Quizzes: More related questions on the self quizzes; Need quizzes for each topic (1) or Regular mini quizzes every fortnight (1); No online quiz; The online test doesn't have a time limit; More quizzes online (1)
Other comment: Study sheet for test; More careful marking of test; Create answer to practice questions; More practice tests (2) and worked solutions for online self-tests(3)

4.4.4.4.4 Tutoring

In response to the variety of open ended question students indicated they wanted better teaching in tutorials and structure and others more tutorial time, questions and answers (refer, Table 4.44).

Table 4.44 Student responses regarding tutoring and practical class

Better teaching: Better tutorial (2), I get little to no help in tutorials. Smaller tute groups are needed and the practical part of Thursday lecture should be turned into a tutorial; Need good tutor that can explain when you don't understand something; Bit more connection between lecturer materials and tute. I felt I learned more in tute and PASS; More explanations of problems in the tute and lectures; Tute work should correspond with the lecture of the week; Tute involving more discussion about problems in maths; Get tutors who actually like helping their students (1); Nicer and more helpful tutors (1)
More time: More tutorial time (6) and less lectures (3), learn by doing; More questions with answers for practice class after test with lecturer is really good; Getting tute sheet questions before tute; more tutes means more help plus questions answered
Timing issues: I would like to have the solutions to our tute sheet available just after the tutorial when I have fresh idea how to solve the task; Have all tute times before the weeks exam so some students are not at a disadvantage; Increase time and solve at least a sample of questions in practical test by lecturer; Mandatory online tute before in-class tutorial; Better lecture time 8:30 is no good, (2); Not having 8:30 class; Makes more spread out; lecture not on the morning.

4.4.4.4.5 Practical class

The practical classes were groups of approximately 50 students. The group work was used to reinforce the *Maths in Action* theme, and as a consequence some lectures were replaced. The lecturer in the first lecture explained the objectives of this section (refer, Table 4.45).

Table 4.45 Objectives of practical

Maths 'in action'

The objectives of this section are to develop your mathematical skills as follows:

- To use basic mathematical skills to solve a range of problems relevant to scientific disciplines
- Be capable of applying logical, analytic and creative thinking to a range of problem
- To understand the applications of mathematics to other fields
- To apply mathematical principles to the formulation and solutions of problems

Students attended four practical classes, one in each of the weeks 2, 3, 5 and 6. Each practical was one hour in duration and during the classes the students worked in groups, applying the lecture material to *Maths in action* problems (refer, Table 4.46).

Table 4.46 Example question of maths in action

Arrhenius's greenhouse law for carbon dioxide is

$$\Delta F = \alpha \ln\left(\frac{\mathrm{C}}{\mathrm{C}_0}\right)$$

In this equation C is the concentration of carbon dioxide measured in parts per million by volume (pmmv); C_0 denoted a baseline concentration of carbon dioxide, and ΔF is the radiative forcing, measured in Watts per square meter. A positive radiative forcing tends on average to warm the surface of the Earth whilst a negative forcing tends on average to cool the surface. The Intergovernmental Panel on Climate Change (IPCC) assigns to the constant a value α=6.3.

Determine the change in ΔF if the concentration of carbon dioxide in the atmosphere is (a) doubled and (b) halved.

Comments from students in relation to the practical classes suggested they considered the practicals to be quite beneficial (refer, Table 4.47).

Table 4.47 Student responses

Benefit: practical classes were quite beneficial. I would have liked these to be continue through the semester; Continue practical class through the semester; The hour of practice questions at the end of Thursday lecture were very helpful and should be continued; Practical classes should continue through the session; Continued practical classes through the session not just in the first weeks before midsession; More tutorials in class and practical classes.
Other: Questions in class should be more progressively difficult; Timing issues: More time for practice questions.

4.4.4.4.6 Textbook (Lecture Handbook)

Students wanted the lecturer to improve aspects of the textbook, which is the lecture handbook including updating it with more worked examples, better layout and explanation (refer, Table 4.48).

Table 4.48 Comments regarding the textbook

Lecture book is not that easy to understand; Lecture book could explain things better.
Redesign lectures notes; Better lecture notes available.
Short summary of topic covered would be helpful.
Having all answers clearly matched in lecture book; All answers in the book.
The textbook needs to have more solutions and to be laid out better. I could not find solutions to these problems online either.

4.4.5 Valuing of online learning resources

Over the three years chi-square analyses revealed there was a significant difference in the valuing of three of the resources, S*ummertime Math*; *other additional resources* and *orientation video resources* (refer, Tables 4.49 and 4.50).

Table 4.49 Usefulness of online learning resources

Learning resources in eLearning homepage	2010 extremely & moderately useful		2011 extremely & moderately useful		2012 extremely & moderately useful	
	N=101	%	N=48	%	N=61	%
Tutorial solutions	95	96.9	39	90.7	55	91.7
Worked examples	95	96	37	88.1	59	98.3
Assessment solutions	96	96	36	83.7	57	95
Sample test papers	94	94.9	41	95.3	55	93.2
eLearning Homepage	90	90.9	38	88.4	50	84.7
Self tests	87	88.8	36	85.7	50	84.7
Other additional resources*	84	84.8	34	81	36	64
Forum eLearning page	77	78.6	21	51.2	37	64.9
Learning design map	-	-	-	-	19	34.5
Summertime Math *	77	78.6	31	73.8	35	60.3
Orientation videos resources *	-	-	25	59.5	27	45.8

Table 4.50 Chi-square Usefulness of online learning resources

Learning resources in eLearning homepage	Chi-square 2010-2011		Chi-square 2011-2012	
	χ^2	P	χ^2	P
Tutorial solutions	1.333	.248	.303	.582
Worked examples	.005	.942	.987	.320
Assessment solutions	.528	.468	.036	.849
Sample test papers	.229	.632	.698	.404
eLearning Homepage	1.692	.193	.020	.887
Self tests	.667	.414	.314	.575
Other additional resources	.001	.974	4.167	.041
Forum eLearning page	3.718	.054	.414	.520
Summertime Math	.286	.593	3.853	.050
Orientation videos resources	-	-	6.872	.009

The design of the *Summertime Math* resources is clearly popular with many students, with requests for "more practice tests and worked solutions" and "more examples with worked solutions". With its self-tests, theory refreshers, worked examples, practice examples and links to other websites, many students seek further resources of this kind for the topics not included in it. While students were provided with videos across all topics, the perceived usefulness of the orientation videos appeared to decline. Students still requested extra worked solutions and need more videos (refer, Table 4.51) even though a complete set was provided to cover all topics. As for the *Head Start*, it seemed that some students were not aware of the resources available in eLearning.

Table 4.51 Student concerns about online resources

Videos: Video resources are great; More videos (10); video resources very useful and made learning a lot more easy with visual demonstration; Step by step videos on working out of math in action; Add the maths tutorial video with each topic as I found these more useful than lectures; More videos for all topics (3) because they are useful if you struggle with the concept; Having another person explain a concept can be helpful; to help answer questions; for worked example

Summertime Math: Summertime Math was awesome; More videos explaining how to do certain example like Summertime Math; Summertime Math very useful but it covers the half of the content for example Summertime Math does not cover trig, growth and decay or limit; Summertime Math needs more videos I found them the most helpful and more videos covering more topics would be great; Love Summertime Math website; Summertime Math need to have more information this site is really helpful especially videos the live solution, there should be more.

Design Issues: I did not know (or was aware of) videos resources (8); The videos outlined what the topic would be about but failed to extend on major points; need to understand what was need to do the work.

Other: Videos personally were not useful.

4.4.6 Attributes of eLearning

From 2010 to 2011 all five measures, *eLearning better access to material*, *structured to know required assessment*, *support through difficulties in learning*, *structure of*

eLearning page help understand objectives, and *what the lecturer wants is clear*, showed significant improvement. However from 2011 to 2012 for all seven measures of usefulness, chi-square analyses revealed there was a significant difference with a decline in usefulness reported by students (refer, Tables 4.52 and 4.53).

Table 4.52 The design of eLearning Pages

Gain from the design of eLearning Pages	2010 Total of extremely & moderately useful		2011 Total of extremely & moderately useful		2012 Total of extremely & moderate Useful	
	N=101	%	N=48	%	N=61	%
eLearning better access material	80*	80.8	41	97.6	41**	69.5
Structured to know required assessment	77*	77	39	95.1	33**	57.9
Support through difficulties in learning	75*	75	39	97.5	35**	60.3
Structure of eLearning page help understand objectives	74*	74.7	41	97.6	29**	49.2
What the lecturer wants is clear	65*	65	36	87.8	26**	44.1
Clearly understand what have do and resources to help do task	-	-	40	97.6	40**	70.2
Know what kind of support you have	-	-	40	97.6	41**	71.9
The organization of work and learning material	-	-	-	-	48	84.2
The connection between tasks and resources	-	-	-	-	43	76.8

* Significant change with improvement from 2010 to 2011

** Significant change with decline from 2011 to 2012

Table 4.53 Chi-square the design of eLearning Pages

gain from the design of eLearning Pages	Chi-square 2010-2011		Chi-square 2011-2012	
	χ^2	P	χ^2	P
eLearning better access material	26.429	.000	32.662	.000
Structured to know required assessment	31.199	.000	30.547	.000
Support through difficulties in learning	37.409	.000	37.650	.000
Structure of eLearning page help understand objectives	28.355	.000	35.069	.000
What the lecturer wants is clear	36.936	.000	31.516	.000
Clearly understand what have do and resource to help do task	-	-	31.516	.009

In response to the open ended question students are split between those who think the structure is good and those indicating changes need to be made. What is different between redesign 1 and redesign 2 is that students are now commenting that there are too many levels in accessing materials and too many links (refer, Table 4.54) with comments about the “ugliness” of design disappearing.

Table 4.54 Students responses about online resources and navigation

Good design: eLearning site is set in a way which is easy to find what you are looking for; eLearning has better structure; eLearning site is very different to other subjects and it is much easier to find resources (2); eLearning is different and useful; Structure is good in the eLearning; eLearning useful for revision; eLearning page very different from other subjects (2); Set out reasonably and clearly. Information was east to find when required; eLearning page has a good design (3); eLearning is quite easy to navigate.
Resources: eLearning site more interesting but still lacks information; eLearning has some good resources but not much on differentiation; resources should include all semester not just the beginning; eLearning site is very useful and a lot of helpful resources available; Lectures should be available online; Have all the worked answers to the lecture materials online; Put the text online as well as book, it is more helpful to write out working than copy answer; Provide more written examples with structured answers to use as a resources if you could not attend lectures; Reference materials available on eLearning; more in lectures so students understand what is available; Have more links that can help with sections; Lecturer notes if you miss a lecture you can't catch up with on your own; Upload relevant materials
Too many pages/links: eLearning has too many links (2); A folder for each topic covered so each part is separated; eLearning page is too complicated and moving between pages is time consuming; eLearning need to be more quickly accessible; Needs simple layout and not too many in and out and one front page with access to all modules; eLearning design is slightly messy; eLearning more complicated; Make it more clearer and more accessible; The structure of eLearning is difficult to find resources; Need better eLearning page; Upload only relevant stuff
Other suggested improvements; Tutorial extremely helpful, I like the weekly links; More spread out that makes final exam less stressful.

Student comments in 2010 suggested that improvements could be made to the eLearning site. In 2011, comments indicated that the eLearning site had improved, "Very well organized easy to find things" ," It is better customized", "It is easier to find what is needed", "Very different-clear", "Easy to see what part of course we are up to", "Very easy to navigate and user friendly". In 2012 they indicated eLearning is useful although moving between pages is time consuming (refer, Table 4.55). For the Head Start students either do not read emails or they are late with enrolment.

Table 4.55 Student comments on the eLearning site

eLearning is good: eLearning very good(n=3); I think the eLearning site is set at in a way which is easy to find what you are looking for (n=2); Better organized home page(n=3); eLearning very useful and help resources are available.
Navigation: eLearning is quite easy to navigate; It is very different to that of other subjects and it is much easier to find resources (n=2); It is different to many of my other subjects (n=2).
Moving pages: Moving between pages in the eLearning is time consuming (n=3); Have folder for each topic rather than lectures over view.
Summertime Math : *Summertime* Math needs to have more information to cover all topics (n=5); Summertime Math very useful but it covers half of the content required (n=3); Summertime Math is helpful
Head Start: Head Start was excellent and helpful (n=7) would be more beneficial if it covered every topic in Math151and more worked examples were provided; Head Start more easily accessed; I was not aware about Head Start program (n=15); Videos need to outline what the topic is about

4.5 Conclusion

The eLearning site contains multiple resources systematically organized and positioned and accessible for students to develop their knowledge and to practice

their skills in their own time. As constantly echoed by students in this study, learning resources designed, chosen and developed for flexible technology-based learning for students, are essential in creating on-line learning environments (Oliver & Herrington 2001). Learners need to have a variety of available resources and to have choices in the resources that they use and how they are used (Oliver & Herrington, 2003). This is supported by students request for an extension of Summertime Math, which provided a variety of resources. This variety of material is made accessible to learners to help them understand and complete tasks. In addition to a textbook, the MATH151 eLearning resources provide theory and printed worked examples for each topic, links to relevant websites, practice examples, tasks, worked solutions, references additional to read and quiz materials. Streaming video can support the learning of first year students (Green, et al., 2003). With *Redesign 2* students were provided with comprehensive sets of video resources covering all topics, enabling access to key concepts in many ways, with the use different mediums, video, lecture and text showing the use of concepts in a variety of situations, building in real world illustration of concepts. The actual lectures are not provided through eLearning. The discussion forum in the eLearning site allows students to share ideas to solve problems. Some students used the forum to ask questions and/or to answer them, but this is a small proportion of the student body and perhaps techniques need to be implemented to increase this interaction (Mokoena, 2013). Opportunities for feedback regarding work are high as there are many practice examples and self tests with solutions for self-checking.

MATH151, as a core science subject, attracts students from many disciplines, many of whom do not see the relevance of mathematics to their chosen career. The need to establish relevance, and this involves a variety of disciplines, not just the generic science, is heard through comments in the student evaluations.

Over the three years redesigning the MATH151, performance in terms of improved pass rates did not occur. The basic skills for students enrolling in MATH151 are variable over the three years, with in 2012, only 36% of students passing the *Week 4, Basic Skills test*, covering prerequisite knowledge. In terms of engagement, after *Redesign 2* students did report spending more time working on MATH151, which is puzzling when the performance did not improve until one considers that the entry

skills of these students is weaker than for students in the previous year. Possibly spending more time has possibly mitigated against an otherwise higher failure rate.

There is no significant difference in student perceived competency in their ability to solve problems in any of the topic areas for the three different implementations. Valuing of offline resources revealed only two significant differences in the valuing of any resources over the three years. However, given the ability of students was lower in 2012 and the failure rate is comparable to previous years, it is likely that the resources have had an effect on student learning as the expectation is that when ability declines the failure rate will increase. That has not happened; the failure rate has remained stable.

There was a significant difference in the valuing of three of the resources, S*ummertime Math*; *other additional resources* and *orientation video resources*. Several significant differences were observed when comparing the different design attributes of eLearning site in 2010, 2011 and 2012. From 2010 to 2011 all five measures, *eLearning better access to material*, *structured to know required assessment*, *support through difficulties in learning*, *structure of eLearning page help understand objectives*, and *what the lecturer wants is clear*, showed significant improvement. However from 2011 to 2012 for all seven measures of usefulness, there was a significant difference with a decline in usefulness reported by students. Students wanted everything on eLearning; more resources and activities. Although they essentially got this in *Redesign 2*, the second redesign was not seemingly as successful as *Redesign 1*, which students clearly found better in terms of the design attributes.

In terms of video design concept maps are a key element of the design process, particularly for the development of orientation and overviews. They are excellent for focussing the designer on the concepts that are to be explained or demonstrated. A video contains visual and audio components and the latter should focus on explaining, rather than merely reading the developing solution. In postproduction, attention should be drawn to particular parts of the solutions using highlights, graphics and animation to illustrate concepts or processes and *in* accord with student wishes *to draw out the step-by-step component of the problem solving*. Worked examples with the steps highlighted are preferable to demonstrations of how to do a

problem (Algarni, 2013).

In terms of design of the eLearning site, according to the students, the key suggestions are to reduce the number of page levels used to access materials. It is suggested that in the next redesign that three pages be eliminated, creating a flatter structure rather than hierarchical. Although there is a huge time demand in redesigning, after the first redesign subsequent changes are less complicated. Certainly the design has allowed the design team to identify missing support and resources.

The researcher has not made any changes to the existing resources but students clearly suggest that existing resources need to be improved. While the redesign was associated with students spending more time working on the subject it is reasonable to expect that to change performance the primary resources: lecture, tutoring and text need to be changed rather than adding to or modifying the support learning resources. In adding additional support materials, in this case predominantly videos, it is important to take care with the design lest there be too many layers, too many pages and too many links and thereby too much time in accessing resources. This is a major issue with design particularly with multi-level design. A move to using the new Moodle learning management system in 2014 will necessitate design principles which involve fewer layers as it does not support a folder system.

5 Professional development for technology in mathematics education

In this case study two aspects of technology use are addressed: 1) the identification of technologies used in a good quality Australian tertiary mathematics department; and 2) identification of methods of staff development, both from a staff learner's perspective and from a professional developer's perspective. The identification of how and why different technologies were used and the difficulties to learning them in terms of self-development and staff development involved interviews with 28 mathematicians and statisticians and a survey of 33 postgraduate students from the School of Mathematics & Applied Statistics (SMAS) at UOW. Three of the most notable resource differences between institutions in the Middle East and those in Australia were: Internet access, the use of eLearning systems and the variety of mathematics and statistical software available. The second aspect, the staff developers' perspective, involved 24 interviews with staff involved in staff development across a range of academic and administrative areas. The interviews were used to identify the strategies and the approaches staff used and the difficulties in terms of self-development and staff development.

5.1 Aims

The broad aim of this case study was to investigate ways to implement the best practice of western technology in developing Middle Eastern countries. This involved identifying ways to capitalize on lessons learned through educational developments that have been tried and tested in order to deliver an advanced starting position for staff and students who are beginning their exploration of what is possible with technology. More specifically the aims were to:

- Identify which technologies are used, how they are used and what lecturers and students gain from their use.
- Determine what staff and postgraduate students require in terms of professional development in order to use these technologies
- In terms of creating a staff development program for staff in the Middle East what do staff developers see as appropriate strategies?
- What can be learned regarding the applicability of teaching and delivery of education in Australian context that could be applied to the Middle East countries?

The western country chosen was Australia, the university, the University of Wollongong and along with this the School of Mathematics and Applied Statistics. These were decisions made by the researcher, in accordance with choice of a country and a high quality institution in which to study.

5.2 Higher education in Australia

The higher education sector in Australia consists of 37 public universities, 2 private universities and 150 or so other providers of higher education including a Vocational Education and Training (VET) sector comprised of Technical and Further Education Commission (TAFE) that focuses on skills and training (Höj, 2011). Australian universities offer a variety of undergraduate and postgraduate degrees and diploma courses with the duration of programs ranging between two and five years (Parker, 2012).

Australia has developed into one of the world’s leading international study destinations with many institutions ranked in the top 500 in the world (Walters, 2012). The number of international students has increased from fewer than 50,000 in 1991 to around half a million in 2010 (Walters, 2012). A significant reason for the increasing growth of international students studying in Australia is the perception that Australia is ‘safe, secure and relatively tolerant’ (Marginson, 2002). Other reasons include the quality of education, the credibility of the qualifications, and the reputation of the institutions, a beautiful climate and the friendly attitude of the Australian people to visitors (Obeng-Odoom, 2012).

5.3 University of Wollongong (UOW)

The University was established in 1951 as a college of UNSW. In 2012 UOW had more than 936 members of staff across 8 faculties. In terms of studying the best of western practice the UOW received the highest rating in the broad discipline area of Chemical Sciences. Areas such as Law, Public Health, Psychology, Mathematical Sciences, Earth Sciences, History and Archaeology and Creative Arts at UOW were also recognised as leaders for the high quality research outputs and contributions to their disciplines (Times Higher Education, 2012) (refer, Table 5.1).

Table 5.1 UOW ranking

Top 1% of world universities	The 2013 Leiden Rankings from The Netherlands placed UOW in the top 1% of world universities for research quality
Top 2% of world universities	The *Times Higher Education* World University Rankings 2012/2013 Academic Rankings of World Universities (ARWU) 2012
Top 50 in the Top 100 Under 50	Included in the *Times Higher Education* Top 100 Under 50 Rankings for universities under 50 years old in 2012 and 2013
Globally rated Five Star University	Australian Good Universities Guide 2013

* Data source::http://www.timeshighereducation.co.uk/world-university-rankings/2013/one-hundred-under-fifty/institution/university-of-wollongong

The 2011 Good Universities Guide confirms UOW's longstanding position as one of the country's leading research institutions. UOW received five stars in seven key areas, where only the top 20 per cent of universities in Australia can be awarded the maximum of five stars in any one category. These categories include: getting a job, positive graduate outcomes, staff qualifications, research intensity, graduate satisfaction generic skills, and staff to student ratio.

At the commencement of the study UOW had eight faculties: Arts, Commerce, Creative Arts, Education, Engineering, Health & Behavioural Sciences, Informatics, Law, Science, Graduate School of Medicine and the Sydney Business School (refer, Table 5.2).

In addition to the main campus in Wollongong there are regional campuses at Shoalhaven, Batemans Bay, Bega, and the Southern Highlands with an Education Centre in Southern Sydney and an offshore campus in Dubai. It also has an Innovation campus in Wollongong, the Sydney Business School in the centre of Sydney and UOW College, a subsidiary of UOW, offering alternate pathways to UOW through university preparation courses. UOW College enrolled 1,588 students from 35 different countries in 2011.

Table 5.2 The faculties at UOW

Faculties	Schools
Faculty of Arts	▪ Language Centre ▪ Indigenous Studies Unit ▪ School of English Literatures and Philosophy ▪ School of History and Politics ▪ School of Social Sciences, Media and Communication
Faculty of Commerce	▪ School of Accounting and Finance ▪ School of Economics ▪ School of Management and Marketing
Faculty of Creative Arts	
Faculty of Education	
Faculty of Engineering	▪ School of Civil, Mining and Environmental Engineering ▪ School of Engineering Physics ▪ School of Mechanical, Materials and Mechatronic Engineering
Faculty of Health and Behavioural Sciences	▪ School of Health Sciences ▪ School of Nursing, Midwifery and Indigenous Health ▪ School of Psychology
Faculty of Informatics	▪ School of Computer Science and Software Engineering ▪ School of Electrical, Computer and Telecommunications Engineering ▪ School of Information Systems and Technology ▪ School of Mathematics and Applied Statistics
Faculty of Law	
Faculty of Science	▪ School of Biological Sciences ▪ School of Chemistry ▪ School of Earth and Environmental Sciences
Graduate School of Medicine	
Sydney Business School	

In 2011, UOW had over 19,291 undergraduate students and about 8781 postgraduate students. Of the total number of students about 7446 are international students (Planning Services UOW, 2011). International students therefore constitute about 25 per cent of the student population.

From 2013, UOW began to offer subjects in the Open Education Resource University (OERu) (http://open.uow.edu.au/courses/index.html), to provide free open courses to learners anywhere in the world, along with open resources, (refer, Table 5.3).

Table 5.3 UOW Open courses

Offering	Description
Understanding Common Diseases	4 week course. Open for enrolments on October 14th 2013. Study starts November 18th 2013. Covers 4 of the most commonly occurring diseases in the world: High blood pressure, Diabetes, Reflex, and the Common cold and flu
The Reluctant Mathematician	First Maths MOOC for 4 week course. Open for enrolments December 2013. Study starts February 2014. Starting with 4 popular topics, will be expanding it over the next 6 months and setting more dates for joining additional online classes.
Contemporary Issues in Ocean Governance – Maritime Enforcement and Security	4 week course. Open for enrolments on December 2013. Study starts January 2014.Aquatic environmental vandalism and modern-day piracy on the high seas will all be part of this very topical online course.

* Data source: http://open.uow.edu.au/resources/index.html.

Tran (2011) argues that a decrease in direct government funding in Australia, has resulted in an increased ratio of staff to students in the higher education sector, increased teaching loads and larger tutorials and lectures. As a consequence academics are under more pressure to meet the needs of international students and find it more difficult to respond to unfamiliar and diverse student characteristics. Indeed many lecturers perceive a dilemma between how to address international students' needs whilst keeping up with what they perceive to be institutional academic expectations and standards (Ryan & Carroll 2005). One of the priorities for UOW is providing support for students who experience academic study difficulties.

UOW provides counselling service for students as well as online resources and academic support programs. These services include:

- Student Support Advisers (SSAs) to provide individual support to students, with a particular focus on assisting students with disabilities and international students.
- The Learning Development unit (LD) to support the student transition to the first year of university study. LD provides workshops for undergraduate and postgraduate students on a range of study, research, academic writing and language related topics, and individual consultations are provided for research and coursework students across all faculties. In 2011, this was further supported through the appointment of a lecturer to focus on supporting mathematical and statistical thinking (Excellence Leadership Innovation Connect, 2011).
- An eLearning system to provide students with multiple support resources for 80 per cent of UOW undergraduate subjects.

- A Disability Support Program, to support the academic development of students with disabilities, including those with mental illness and learning difficulties.
- Peer Assisted Study Sessions (PASS) focused on improving academic progress and retention of students.
- A first year at UOW Website to support the student experience and the transition of UOW students, particularly during their first semester of study (https://www.uow.edu.au/student/services/fye/index.html).

5.4 School of Mathematics and Applied Statistics (SMAS)

In 2011 the School of Mathematics and Applied Statistics (SMAS had 43 academic staff and 6 general staff members as well as access to a faculty pool of staff for technical support. In 2011 it was an associate member of the *Australian Mathematical Sciences Institute* (AMSI), a collaborative enterprise of Australia's mathematical sciences for collaboration in the mathematical sciences to strengthen mathematics and statistics especially in the universities. SMAS offers a range of undergraduate scholarships, an advanced degree and Dean's Scholars options for outstanding students, a small number of undergraduate scholarships such as those funded by *Tibra Capital* plus a number of student prizes (http://eis.uow.edu.au/current-students/prizes/smas/index.html). Research in SMAS covers a wide range of pure, applied and financial mathematics as well as applied statistics, in addition to researchers involved in mathematics and statistics education. Two research professors are externally funded, one by the Australian Bureau of Statistics, and the other by CSIRO and Grains Research Development Corporation partnership.

Baharun (2012) discuss a range of learning supports for students of mathematics and statistics at UOW. These range from subject specific supports to generic supports provided by the institution (refer, Figure 5.1). Technical support including the provision of assistance for any technical issues students may face in online and blended subjects is also necessary (Lee et al., 2011).

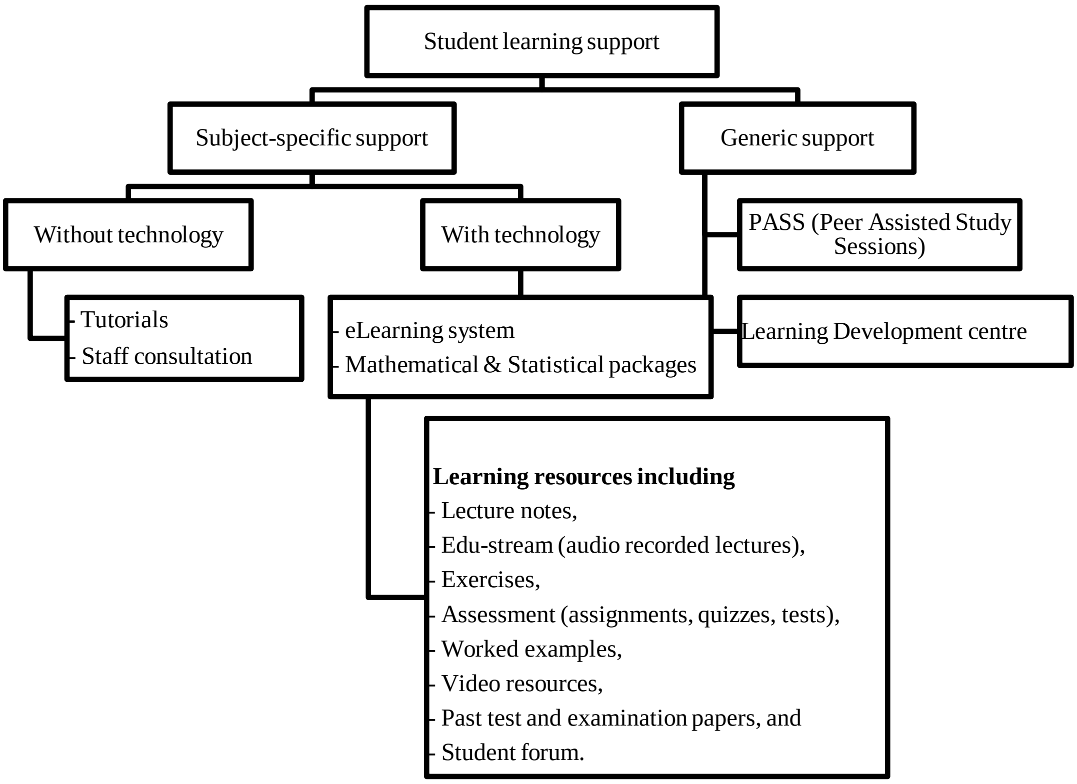


Figure 5.1 Learning support of mathematics and statistics

SMAS was the site chosen by the researcher to study and to subsequently to investigate the use of technology to improve education. Following the examination of artifacts that reveal the primary resources available for teaching mathematics and resources used to support student learning at UOW, this chapter explores the needs of staff for professional development in relation to these resources from both the user's perspective and that of the staff developers.

5.5 Research Design

This case study involved three key phases: the examination of artifacts from UOW in relation to mathematics education; data collection in the form of surveys for postgraduate mathematics students to identify uses of technology, interviews for academic staff regarding use of technology and needs for professional development; and interviews of staff developers to examine techniques of staff development; and finally reflection upon data (refer, Table 5.4).

Table 5.4 Research design

Artifact analysis	• Mapping Units providing ICT facilities and/or support and/or professional development at UOW • Mapping of subjects • Mapping of software available in the computer laboratory in SMAS
Data collection	• A survey of mathematics doctoral students at SMAS • Interviews of academic staff at SMAS • Interviews of professional staff developers at UOW
Reflection	• Observation, mapping and data collection analysis to select topics for the development of a professional development package for staff in the Middle East

5.6 Artifact analysis: Units providing ICT facilities and/or support

The preliminary stage to address the challenges confronting developing countries is to learn from best practice in advanced economies. For instance, developing countries can utilize wireless technology rather than cable (Wright et al., 2009). Sife et al. (2007) suggests that higher learning institutions can adopt freeware and open source software for teaching and learning activities. Freeware does not necessarily imply an inferior product as support documentation is often available and sometimes there is online user support with questions answered via blogs.

This section discusses the preliminary stage that involves the mapping of information and technology services, mathematics subjects and academic programs on offer, and mapping software available in UOW central and mathematics laboratories. This mapping, together with an earlier literature review (refer, Section 2.3.4), is used to identify the components and functionalities of the best technologies. These then form the basis of interviews and surveys with staff, regarding technology use and functions, leading into the design of a professional development package.

5.6.1 Mapping ICT services

Several units on campus facilitate faculties and units teaching and research with an emphasis on engagement and support. Mapping the services provided by these units provided preliminary information as to their nature, in particular technology and support available for staff and students. These units include:

- Information Technology Services (ITS)
- Learning, Innovation, Facilities and Technologies (LIFT)
- Centre for Educational Development, Innovation and Recognition (CEDiR)
- Learning Design Unit (LDU)

- Centre for Academic Systems & Resources (CASR)
- Academic Development Unit (ADU)

In the third phase of this case study the researcher interviewed staff from several of these units to gather a more complete picture of professional development practices.

5.6.1.1 Information Technology Services

The ITS website (http://www.uow.edu.au/its/index.html) indicates a wide range of services provided for staff in relation to administration (student management systems), teaching (for example, workshop awareness activities such as iPad in Tertiary Education Seminars) and research (for example, High Performance Computing facilities). ITS also facilitates student learning, providing policy and technical facilities such as, Internet access and quota, software and email accounts. For many years ITS has procured a University-wide licences for some packages such IBM SPSS 19, IBM SPSS AMOS, SAS and JMP and supported others such as the freeware while R and RStudio and supported faculties and schools which use as numerical computing applications such Maple, and MATLAB. The IT infrastructure incorporates the provision of computer, network and communication services to the campus community for academic teaching and research and for general administrative functions. Ongoing IT Training is a valuable resource to the University community. By 2014 ITS was trialling remote access to laboratory software for statistics students using R, SPSS and SAS.

By 2012, about 80 per cent of UOW undergraduate subjects were to have a site in the Learning Management System (LMS), Blackboard Vista version 2 (Excellence Leadership Innovation Connects: Annual report, 2011). In the final year of this thesis, 2013, there was a major initiative transferring to a new UOW Learning Management System consisting of a platform of connected tools and systems (Moodle) including automated enrolment of students and Echo360 as a new lecture recording system. These are used with an existing learning content management system (EQUELLA) providing sophisticated storage, handling and retrieval of online content that can be accessed through Moodle. The interface of this system differs, providing a much flatter structure as requested by students in the case study *Redesign of eLearning*, (refer to an example, Figure 5.2).

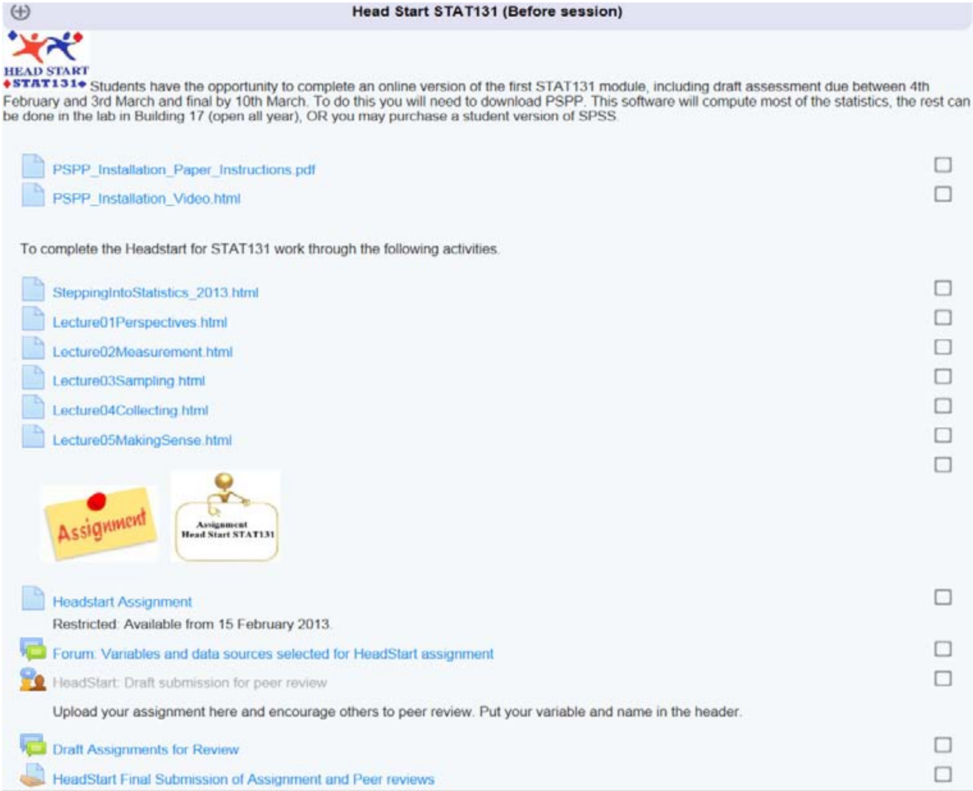


Figure 5.2 STAT131 in Moodle

The eLearning sites (Moodle) provide extra resources and support to students both on and off campus and across campuses that enable them to communicate with their lecturers and tutors, set up a wide range of assessment activities and to use tools that the University wishes to plug-in to the system, for example the ePortfolio Mahara. In 2013 staff at UOW were preparing introductory resources for the different elements of the platform, tailored training was provided for small groups and support was provided for individuals. As the 2013 year ended, a movement toward introducing Cloud computing services for staff was beginning to emerge, with possibilities such as remote access to computer laboratories by students being explored.

5.6.1.2 Learning, Innovation, Facilities and Technologies (LIFT)

The LIFT website (http://www.uow.edu.au/asd/lift/teachingspace/index.html) indicates it provides all equipment for teaching spaces such as overhead projectors, screens, computer PCs and laptops, smart boards, document cameras, video conference and lecture capture. Students and staff can also borrow equipment for teaching and learning through the central borrowing system. This includes

- Cameras: Video – Digital or Still - Digital
- Projectors: Desktop video/data or overhead projector
- Computers: Macintosh, PowerBook or PC laptop
- Audio: Digital recorders, Small PA systems, Microphones

5.6.1.3 Centre for Educational Development, Innovation and Recognition (CEDiR)

The CEDiR website (http://www.uow.edu.au/asd/cedir/index.html) indicates it offers blended University Learning and Teaching (ULT) subjects to all UOW academic teaching staff. ULT is a work-based professional development program for university teachers designed to enhance teaching effectiveness, and provides an educational context for ongoing career development. It also supports academics in applying for promotion and reward and recognition. The unit also supports staff with learning and teaching grants to investigate learning and teaching issues or to develop innovative solutions to discipline-specific and institution-wide challenges. Each year staff are invited to apply for the Faculty Scholars Program to develop teaching leadership capacity in their faculty.

5.6.1.4 Learning Design Unit (LDU)

The LDU website (http://www.uow.edu.au/asd/cedir/learningdesignunit/index.html) indicates it supports staff with the development, enhancement and sharing of good practice in educational design. In 2013, this unit has been central to the smooth transition of subjects to the new learning management system, Moodle.

5.6.1.5 Centre for Academic Systems & Resources (CASR)

The CASR website (http://www.uow.edu.au/asd/casr/location/index.html) indicates it provides staff with support in teaching services, eTeaching systems, including use of EQUELLA, educational systems development and project management.

5.6.1.6 Academic Development Unit (ADU)

The ADU website (http://www.uow.edu.au/asd/cedir/academicdevelopmentunit/index.html) indicates that it undertakes professional development for academic staff at UOW. It coordinates and facilitates the University Teaching and Learning (ULT) program which supports all academic staff in improving their teaching as well as providing additional workshops, events, and invited speakers.

5.6.2 Mapping of subjects

In the early stages of this thesis (2010) a mapping of subjects and courses at UOW was undertaken with a view to identifying topics taught, the lecturers who taught them so they could be interviewed in relation to technologies used. This mapping was also to facilitate comparison with the subjects taught at Libya's University of Benghazi.

SMAS offers a variety of subjects and degrees at undergraduate and postgraduate level in the mathematical sciences, allowing for specialisations in pure and applied mathematics and applied statistics. A complete current listing of degrees is available at http://www.uow.edu.au/handbook/yr2011/ug/informatics/H11006876.html.

Students, who enrol in a Bachelor of Mathematics, must satisfactorily complete at least 144 credit points from the subjects prescribed for the Bachelor or Mathematics and the General Schedule (UOW handbook online, 2011). The degree undertaken over three years full-time or part-time equivalent is designed to give the graduate a solid foundation in the study skills needed to pursue a career as a professional mathematician or statistician. The requirements for the Bachelor of Mathematics degree (refer, Table 5.5) are indicative of the mathematics and statistics requirements for all mathematics degrees.

Table 5.5 Requirements for the Bachelor of Mathematics degree

1.	MATH187 AND MATH188	Mathematics 1: Algebra and Differential Calculus Mathematics 2: Series and Integral Calculus
2.	MATH111 AND MATH212	Applied Mathematical Modelling 1 Applied Mathematical Modelling 2
3.	MATH121 OR MATH222	Discrete Mathematics Continuous Mathematics
4.	STAT131 OR STAT231	Understanding Variation and Uncertainty Probability and Random Variables
5.	CSCI114	Procedural Programming
6.	each of the subjects:	
	MATH201	Multivariate and Vector Calculus
	MATH202	Differential Equations 2
	MATH203	Linear Algebra
	MATH204	Complex Variables and Group Theory
7.	at least one of the subjects:	
	MATH212	Applied Mathematical Modelling 2
	MATH222	Continuous Mathematics
	STAT231	Probability and Random Variables (not additional to 2 or 3 or 4)
8.	300- and/or 400-level subjects from the Mathematics Schedule of subjects with a value of at least:	
	a. 36 credit points, or b. 24 credit points, should a major study in Computer Science also be satisfactorily completed, or c. 30 credit points, should any other major study also be satisfactorily completed d. 48 cp being composed of 24 cp of MATH/INFO and 24 cp of STAT subjects should a double major in both Mathematics and Statistics be completed	
9.	Within requirements 1. to 8., a major study in either Mathematics or Applied Statistics, and	
10.	No more than 60 credit points at the 100-level.	
After satisfying the above requirements, the balance of subjects may be selected from either or both the Mathematics Schedule (table 5.4)and the General Schedule		

* Data source: http://www.uow.edu.au/content/groups/public/@web/@gov/documents/doc/uow094867.pdf

One third of the subjects for the degree may be taken from other disciplines, such as computer science, management, finance or science. At 100 level, six subjects are offered (refer, Table 5.6) for inclusion in the Bachelor of Mathematics degree. This degree is accredited by the Australian Mathematical Society.

Table 5.6 Mathematics Schedule of 100 level subjects in 2011

Subject code	**Subjects title**	**Software ***
MATH187 Autumn	*Mathematics 1: Algebra and Differential Calculus:* The subject consists of Differential Calculus and Linear Algebra. The Differential Calculus presents analytical differentiation techniques and analysis of functions within that context. The Linear Algebra covers matrices, determinants and applications of these in the sub-topic of vector geometry.	Maple
MATH188 Spring	*Mathematics 2: Series and Integral Calculus:* The subject consists of Integral Calculus with applications and Series. The Integral Calculus presents a number of analytical and alternate integration techniques plus applications of integration to find areas, volumes of revolution and solve differential equations. The Series covers techniques for finding limits, determining the convergence of series and leads into Taylor series.	
MATH111 Spring	*Applied Mathematical Modelling 1:* Emphasises the physical, mathematical, numerical and computational aspects of the modern usage of applied mathematics in science, engineering and industry.	Maple
MATH121 Spring	*Discrete Mathematics:* The use of non-calculus techniques, especially those of logic and number theory to develop the ability to apply mathematical principles to the formulation and solution of problems. This subject is well suited to computer science students.	
CSCI114 Autumn & Spring	*Procedural Programming:* Introduces the procedural approach to program design and implementation. Covers basic language constructs for defining variables of built-in types, flow control constructs and simple I/O. Explores functional decomposition as a design technique, and the implementation of functions. Introduces simple user-defined data types and aggregates	C++
STAT131 Autumn	Understanding Variation and UncertaintyTopics covered include Displaying variation and summarising data; Statistical computing and report writing; Probability Models: Binomial, Poisson; Modelling Uncertainty: Normal and other continuous distributions; Sampling Distributions. Central Limit Theorem; Inference - Point and Interval Estimation, Hypothesis Testing.	SPSS

*Note 1: all subjects listed use eLearning sites
*Note 2: all subjects are worth 6 credit points
*Note 3: all lecture theatres have data projection facilities

As indicated in Table 5.5, students have some choice in the selection of 200 level subjects (refer, Table 5.7). Subjects such as MATH201, MATH202, MATH203 and MATH 204 are compulsory almost for all students to have a mathematics degree. The choice depends in part upon which 100-level subjects are completed and whether or not they wish to major in applied statistics or mathematics or undertake a double major with some other discipline.

Table 5.7 Mathematics Subjects for 200 level subjects on offer in 2011

Subjects code	Subjects title	Software
MATH201 Autumn	*Multivariate and Vector Calculus*. This calculus of more than one variable. Applications are given to maxima and minima, multiple integrals, vector calculus, line, surface and volume integrals, and to geometrical problems	
MATH202 Spring	*Differential Equations 2:*Topics covered include exact first order equations, Gamma, Beta and Error functions, Laplace transforms, Fourier series, separation of variables for PDE's, basic numerical techniques, computer packages, and comparative accuracy of numerical techniques	
MATH203 Autumn	*Linear Algebra:* Vector Spaces, Subspaces, Spanning Vectors, Linear Dependence and Independence, Basis Vectors, Column Spaces, Null space, Coordinates and Change of Basis. Numerical Linear Algebra - Measuring the Condition of a System, Gaussian Elimination, Gauss-Jordan, LU decomposition. Linear Algebra - Coordinates and Change of Basis, Inner Product Spaces, Least Squares Problem, Orthogonal Complements, Eigen values and Eigenvectors, Diagonalisation, Linear Transformations. Numerical Linear Algebra - Jacobi Method, Gauss Seidel Method, SOR, Power Method, Inverse Power Method and Deflation.	MATLAB
MATH204 Spring	*Complex Variables and Group Theory:* Extends the calculus of functions of a real variable to functions of a complex variable. Group Theory studies basic algebraic properties common to many mathematical systems and is currently applied in the areas of physics, geology and computer science.	
MATH212 Spring	*Applied Mathematical Modelling 2:* The subject provides insight into the process of Applied Mathematical Modelling in two important areas, heat transfer and Newtonian mechanics, though the modelling skills will be transferable to other areas. The main mathematical technique used is that of solving ordinary differential equations.	
MATH222 Autumn	*Continuous Mathematics:* It deals the properties of the real numbers, and especially with convergent sequences and continuous functions on the real numbers. Careful attention to precision in definitions and arguments is an important aspect of the presentation. This mathematics highlights and explains the power and the limitations of calculus. This course will include derivations of the principal theorems of calculus and their applications.	
STAT231 Autumn	*Probability and Random Variables:* It applies statistical tools to the modelling and analysis of random experiments. Includes graphical and numerical data presentation; statistical computing; discrete random variables (binomial, geometric, hypergeometric and Poisson) and continuous random variables (uniform, Normal and gamma); expected values; transformations; moment generating functions; multivariate distributions; the Poisson process.	swapped from JMP statistical software to R in 2013
STAT232 Spring	*Estimation and Hypothesis Testing:* It develops techniques of statistical inference and statistical analysis. The inference techniques are sampling distributions (such as chi-squared, t and F distributions), methods and criteria of estimation, and hypothesis testing. The analysis techniques are nonparametric testing (such as the sign, median and Wilcoxon tests), simple linear regression and one and two-way analysis of variance.	swapped from JMP statistical software to R in 2013

*Note1: all subjects listed use an eLearning site

*Note2: all subjects are worth 6 credit points

To satisfy the 300 level mathematics requirements Bachelor of Mathematics degree students may select from a number of subjects (refer, Table 5.8, Table 5.9).

Table 5.8 Mathematics Schedule of 300 level subjects on offer in 2011

Subjects code	**Subjects title**	**Software ***
MATH302 Autumn	*Differential Equations 3:* Topics include Laplace and Fourier transforms, series solutions, Hypergeometric and Bessel functions	Maple
MATH305 Spring	*Partial Differential Equations:* Various types of equations and their solutions are discussed. As many equations cannot be solved in analytical form, numerical methods of solution also are considered.	Maple
MATH313 Spring	*Industrial Mathematical Modelling:* It is designed to develop mathematical modelling skills by the examination of case studies relevant to industry. The basic equations are derived from first principles and used to study the transfer of mass and heat, diffusion, solidification and combustion.	No eLearning site
MATH317 Autumn	*Financial Calculus* This subject introduces the financial calculus and the mathematical and statistical modelling necessary for solving practical problems in three fundamental aspects of financial markets (i) financial assets pricing (ii) financial derivatives pricing and (iii) risk management. The course brings together arbitrage principles, stochastic models of stock prices and interest rates, Ito's Lemma and analytical and numerical techniques for solving partial differential equations, to derive, solve and extend models for the valuation and hedging of a variety of vanilla and exotic options and interest-rate products.	No eLearning site in 2011, Site used in 2013
MATH321 Spring	*Numerical Analysis:* It is designed to extend the ideas developed in MATH202 and MATH203 as to how numerical and computational mathematics can be used to solve problems that have no analytic solution. The foci are problems in linear algebra and applications to real world problems. Specific techniques include algorithms for calculating eigen values and eigenvectors of a matrix	
MATH324 Spring	*Calculus of Variations and Geometry:* This subject is about classical calculus of variations and geometric analysis of curves and surfaces. This subject builds on students' knowledge of calculus and linear algebra to represent curves and surfaces and their properties, particularly their curvature, analytically, and to develop several important and widely applicable tools for optimisation of energies in various contexts.	
MATH325 Autumn	*Wavelets:* Major topics covered include inner product spaces and the notion of convergence in inner product spaces, Hilbert spaces and Fourier series in Hilbert spaces, the Haar wavelet, and techniques for the construction and analysis of wavelets in general.	
MATH329 Autumn	*Medical Mathematics and Applications:* This subject promotes the application of mathematical modelling to medicine and related biomedical sciences such as Biochemistry, Drug Delivery, Epidemiology, Forensic Science, Genetics, Neurophysiology and Pharmacokinetics. The subject develops and uses mathematical techniques and computational tools to answer problems that arise in these areas.	
STAT302 Autumn	*Advanced Data Analysis:* selection of topics from: Regression model building and checking; Causal modelling; Cluster analysis; Multi-dimensional scaling; Log-linear models; Generalised linear models; Time series methods; Principal components, Factor analysis; Canonical correlations; Statistical computer packages.	
STAT304 Autumn	*Applied Probability and Financial Risk:* Topics include gambler's ruin, log-normal price models, Value at Risk (VaR) measures and Markowitz portfolio selection.	
STAT332 Spring	*Linear & Generalised Linear Models:* Topics include: Model fitting as an approach to statistical analysis, Exponential family of distributions, Maximum likelihood estimation, Inference methods based on model fitting, Models for multiple linear regression; estimation and analysis; diagnostics and model selection, Generalised linear models for categorical data: logistic regression for nominal and ordinal data, Poisson regression and log-linear models and Additive models	SAS
STAT333 Spring	*Statistical Inference:* Topics covered include, Estimation methods: maximum likelihood and minimum variance unbiased estimation; Hypothesis Testing; likelihood ratio, score and Wald tests,; Evaluating tests; Monte Carlo Simulation methods for inference; Randomisation tests; Monte Carlo Markov Chain; Jackknife methods and Bootstrap methods	• No eLearning site 2011 R

Table 5.9 Mathematics Schedule of 300 level subjects (continued)

STAT335 Autumn	*Sample Surveys and Experimental Design:* Topics covered: Experimental designs (completely randomised, randomised complete block, Latin Square, factorial); the analysis of the data arising from these designs; steps in conducting a sample survey; methods such as simple random sampling and stratified sampling, number raised and ratio estimation.	• SAS, • R, • Access Grid room
STAT373 Spring	*Special Topics in Probability and Statistics 3:* The course introduces students to Bayesian thinking and methods from an applied point of view; covering the use of prior information, Bayes rule and inference in standard situations such as proportions, means and relationships between variables. An applied view on Markov chain Monte Carlo methods will also be given.	• No eLearning site 2011 • R
STAT374 Spring	*Special Topics in Applied Statistics 3:* Course Content: 1. the Deming Quality philosophy (and that of other Quality theorists) 2. understanding variability of processes through statistical thinking 3. the role of management in a TQM organisation 4. the role of quality improvement teams and how to organise them 5. the "seven simple tools" 6. data collection through surveys and experimental design 7. basic statistical methods 8. more advanced statistical techniques such as control charts, SPC, and experimental design 9. Quality standards (ISO9000) 10. complementary quality techniques such as benchmarking	• No eLearning site

* Uses an eLearning site unless specified it does not

*Note 2: all subjects are worth 6 credit points

To complete 300 level mathematics requirements for the Bachelor of Mathematics degree, students may also choose from two 400 level subjects usually jointly taught by Mathematics and Computing Science staff (refer Table 5.10). There are other subjects offered depending on which staff member is teaching the subject.

Table 5.10 Mathematics Schedule of 400 level subjects in 2011

Subjects code	Subjects title	Software
INFO411 Autumn	*Data Mining and Knowledge Discovery:* Introduction to Data Mining and Knowledge Discovery, Data Bases and Warehouses, Data Structures, Exploratory Data Analysis Techniques, Association Rules, Artificial Neural Networks, Tree Based Methods, Clustering and Classification Methods, Regression Methods, Overfitting and Inferential Issues, Use of Data Mining packages.	No eLearning site in 2011 eLearning site in 2012
INFO412 Autumn	*Mathematics for Cryptography:* Logic: informal propositional logic, circuit theory. Natural Deduction style proofs in propositional & predicate logic. Interpretations & Models. Nonclassical logics. Number Theory: elementary number theory, modular exponentiation, discrete logarithms, Galois arithmetic & polynomials, error correcting codes & cryptography. Elliptic curves, groups for cryptography. Combinatorics: combinatorial probability, Knapsack problem, network and graph theory, combinatorial designs, game theory & linear programming applied to cryptography.	No eLearning site

*Note 2: both subjects are worth 6 credit points

Postgraduate degrees are available for students and they are designed to consolidate and expand the mathematics knowledge gained in an undergraduate program and to develop skills in undertaking mathematical research projects (refer, Table 5.11).

Table 5.11 Postgraduate degrees

- Master of Mathematical Studies
- Master of Mathematics
- Master of Statistics
- Master of Financial Mathematics
- Master of Science (Research) Mathematics
- Master of Science (Research) Statistics
- Doctor of Philosophy

5.6.3 Mapping of software packages in the mathematics laboratory

The mathematics laboratory has mathematical and statistical packages for students as learning tools and for academics in their research. Installed are:

- The mathematics software packages: LaTeX, MATLAB, Magma and Maple. These are used to assist lecturers and students to understand mathematical concepts and procedures. Packages such as Maple yield high precision numeric results and can plot functions and data in two and three dimensions. Maat and Zakaria (2011) found that the integration of Maple into the teaching and learning of engineering mathematics improves students' learning outcomes.
- The Statistical packages: IBM SPSS 19, IBM SPSS AMOS, Minitab, MLWin, SAS 9.2, SAS Simulation Studio 1.6, JMP 9.0 which are site licensed by the Information Technology Services (ITS) for use by students and staff at UOW.
- The open source software: R and RStudio and GGobi, free statistical software tools and WinBUGS, statistical software for Bayesian analysis. There is also PDF creator which can create PDF files from any Windows application..
- Microsoft office 2007 which is common software for some purposes such as Word processor: Publish, write, and edit; Spreadsheet: processing information numerical or textual in tabular form; Presentation: generate the presentation content.

5.6.4 Data Collection: School of Mathematics and Applied Statistics

The investigation into the use of technology involved a survey of postgraduate students and interviews with mathematics academic staff, who in addition to their use of technology indicated their need for professional development with the use of these tools.

For the postgraduate student survey 33 PhD students out of a total of 53 students, at SMAS were surveyed regarding their experience as doctoral students in using software. This was to identify how they were using the software to identify ways to apply it to work in developing countries.

Due to the desire to collect data additional to that provided by the students, the

mathematics staff were interviewed. Out of a total of 41 staff, 28 staff in the SMAS participated in a semi-structured interview to identify which technology they used and what professional development they needed to attain the required skills to use the technology or the mathematical or statistical packages.

No change in the use of technology in the last two years has been indicated by 12.1% (n=4) postgraduate students and 17.9% of staff (n=5). However, a small proportion of students and staff have indicated changes, with for example 28.6% of staff respondents having adopted the use of Tablet PC for the delivery of lectures (refer, Table 5.12).

Table 5.12 Use of technology in 2011 in SMAS at UOW

The use of technology changed in the last two years	Postgraduate (n=33)		Staff (n=28)	
	N	%	N	%
The use of Tablet PC for delivering the lectures	1	3.0	8	28.6
Use of eLearning and recording system	3	9.1	6	21.4
No change	4	12.1	5	17.9
Use of PowerPoint Beamer	1	3.0	4	14.3
Access grid and video conference	1	3.0	4	14.3
Mark students assignment by using Tablet PC	-	-	2	7.1
More use of SOLS and email in teaching	3	9.1	2	7.1
Use of communication technology eg Skype	5	15.2	2	7.1
More access to research articles online	8	24.2	2	7.1
Use iPad	-	-	2	7.1
Use R program	8	24.2	2	7.1
More use of library data base	6	18.2	1	3.6
Use of new version of LaTeX	4	12.1	1	3.6

5.6.4.1 Sources of professional development

Learning to use technology by self-learning is common for both postgraduate students (69.7%) and staff (92.9%) (refer, Table 5.13). Asking a friend or searching the Internet is also highly used methods for developing skills.

Table 5.13 Methods used to learn how to use technology

Learning use of technology by	Postgraduate (N=33)		Staff (N=28)	
	N	%	N	%
Self-learning	23	69.7	26	92.9
Asking friend	9	27.3	17	60.7
Searching in Internet, Google, website	14	42.4	13	46.4
Learning by doing	9	27.3	8	28.6
Workshop	2	6.1	6	21.4
Help manual	7	21.2	5	17.9
Reading book	11	33.3	4	14.3
Taught in a subject at undergraduate / master degree	16	48.5	2	7.1
Supervisor	3	9.1	-	-

5.6.4.2 The use of software packages

Undergraduate students learn to use some packages, such as, Maple, MATLAB, SPSS, in their subjects almost by themselves. Students may receive formal instruction in the first class and thereafter learn by asking questions and working together. For example, there are interactive lab exercises in MATH203 for MATLAB and Maple where the lecturer distributes instructions to students in both lectures and tutorials. Moreover, some tutorials running in the mathematics laboratory involve the lecturer demonstrating how to use software packages to students before they submit their assignments. Students may also learn by attending a workshop before they start the subject. Furthermore, during the subject the lecturer may help them with their code. For example, students may be given sample commands that they then modify and use. It could be that sometimes students find this difficult but this is part of the learning process. Consulting services are offered for some statistic packages such as SPSS and JMP.

In terms of commonly used software packages, 96% of staff and 87.9% postgraduate student use LaTeX (refer, Table 5.14), while 67.9% of staff and 45.5% of the research students use Maple. Fewer staff use Mathematica because the university does not provide a site license for it and staff would need to fund its use.

Table 5.14 Maths packages used in research in SMAS UOW

Software packages use in research	How do you use it in research	Postgraduate (N=33)		Staff (N=28)	
		N	%	N	%
LaTeX	Writing theses/paper research	29	87.9	27	96.4
Maple	For programming to solve equation Get numerical result Plot graphics Analyses Simulation	15	45.5	19	67.9
Beamer	Presentation	10	30.3	15	53.6
MATLAB	For programming to solve equations Simulation	6	18.2	6	21.4
Mathematica	For programming to solve equations Plot graphics	-	-	5	17.2
Math type	Typing equation	14	42.4	4	14.3

Thirty two percent of staff and 36.4% of postgraduate students have used the freeware package, R. Stata and MLwiN are used by fewer staff and students (refer, Table 5.15).

Table 5.15 Statistical packages used in SMAS,UOW

Software packages use in research	How do you use it in research?	Postgraduate (N=33)		Staff (N=28)	
		N	%	N	%
R	Analysis of data For programming to solve equations Simulation	12	36.4	9	32.1
SPSS	Analysis of data Statistical modelling Regression analysis	11	33.3	7	25.0
SAS	Analysis of data	8	24.2	6	21.4
JMP	Analysis of data	5	15.2	5	17.9
GHOSTGUM	View plots Compare plot with maple	4	12.1	4	14.3
S	Analysis of data	1	3.1	3	10.7
STATA	Analysis of data	1	3.1	3	10.7
MLwiN	Multiple analyses	1	3.0	2	7.1

Many staff and student know how to use Microsoft packages, but prefer to use LaTeX for typing mathematics (refer Table 5.16).

Table 5.16 Use of Microsoft package in SMAS, UOW.

Software packages use in research	How do you use it in research	Postgraduate (N=33)		Staff (N=28)	
		N	%	N	%
Word	Editing	29	87.9	28	100
Excel	Using table To help statistical packages to analysis data To calculate	24	72.7	22	78.6
PowerPoint	Make slide presentation	27	81.8	16	57.1
Publisher	Use to design business cards, flyers, brochures and posters. Plus share a publisher document by exporting it to an alternate format	2	6.1	1	3.7

Mathematics lecturer's use of lecture materials prepared with Microsoft PowerPoint or LaTeX Beamer. These may be then projected onto a screen delivered by Tablet PC technology or printed on overheads.

5.6.4.3 The use of eLearning site

Seventy nine percent of staff report using eLearning site to support student learning (refer, Table 5.17).

Table 5.17 Other software packages used in SMAS UOW

Software packages use in research	How do you use it in teaching / research	Postgraduate (N=33)		Staff (N=28)	
		N	%	N	%
eLearning	Blended learning	1	3.0	22	78.6
Pdf creator	To convert files	8	24.2	19	70.4
Camtasia Studio	Create video resources	1	3.0	4	14.3
End note	Record reading for theses Organize reference	7	21.2	3	10.7
Others					
Fortran	Run Simulation	1	3.1	2	7.1
TinkerPlots	Plot clear graphics	1	3.1	1	3.6

A variety of reasons are provided for the use of eLearning site but the most common reason given by 60.7% of staff is to provide support resources for learners with 57.1% providing video resources for students (refer, Table 5.18).

Table 5.18 The feature of eLearning site identified by SMAS staff UOW

The feature of eLearning site	Staff (N=28)	
	N	%
Make available support resources for learners (e.g. lecture notes / tutorial resources, labs)	17	60.7
Make available video / audio resources	16	57.1
Provide the assessment feedback	10	35.7
Communication with learners (via forum, discussion announcement)	10	35.7
Give learners access to e-readings (Online readings and links available via library)	9	32.1
Get feedback from students (via forum, discussion announcement)	8	32.0
Have learners submit assignments online (via assignment drop box)	7	25.0
Track student performance, grades, activity and learning materials usage statistics (via grade book)/ tracking in terms of student use of files	6	23.1
Embedded web links for learners	6	21.4
Selective release (group/ dates) e.g. an assessment can be released on particular day & time and then disappear at some other time	6	21.4
Hold online exams and quizzes	3	10.7

Seventy five per cent of staff (n=21) indicated that the greatest impact eLearning site had was its convenience for both students and lecturer. Students can use the eLearning site to access resources. Staff also can upload many resources for them and easily provide feedback although 66.7% of staff indicated preparing the materials for eLearning site increased staff time (refer, Table 5.19).

Table 5.19 The impact of the eLearning site according to SMAS staff.

eLearning impact	Staff (N=28)	
	N	%
Convenience	21	75.0
Increase preparation time	18	66.7
Create options for flexible learning	17	60.7
Help to manage and plan activities for students	16	57.1
Better communication with students	15	53.6
Save time	14	50.0
Provide space for audio-visual elements	14	50.0

5.7 Data collection: Professional staff developers

UOW provides many professional development opportunities for staff teaching students from a broad range of nationalities. The approach is to focus and build on its established strengths in the diversity of intake and culture, quality programs, learning support and student experience (Excellence leadership innovation connect, 2011). The third group interviewed provided insight into professional development practices. This group consisted of twenty-four staff from different centres at UOW. Staff interviewed were drawn from:

- Learning Development
- Learning, Innovation, Facilities and Technologies
- Professional & Organisational Development Services
- Centre for Academic Development Services
- Centre for Educational Development, Innovation and Recognition
- Curriculum Development and Review, Academic Development Unit
- University of Wollongong Library,
- Staff from the Faculty of Education
- Staff from the Faculty of Commerce.

5.7.1 Learning Development

In order to support student learning, UOW established a Learning Development (LD) unit in 1992 that focuses on developing academic language and literacy (ALL). Four staff from the LD unit were interviewed. They indicated that all of the staff in the LD unit have qualifications in teaching such as secondary school, TAFE teaching, adult education or TESOL. Most staff also have a PhD in linguistics, education or in cultural studies and have considerable expertise in understanding written text. Staff in LD understand how writing proceeds and how to help students to write in an

academic way which is acceptable at a university.

Academic writing is an important practice at UOW and plays a critical role in students' academic success. Improving international students' writing practices has become a major area of support for UOW. LD works with students and academics across the university to enhance student learning and to improve both their academic skills and their English language. Participant Donna[1] noted her role as:

> *To share my knowledge….and to influence the teaching practice of my colleagues so that they better understand language development processes and needs of students and how they can teach in a better way or develop more resources that are more helpful for language development.*

LD staff have a role in supporting undergraduate and postgraduate students directly and supporting academic staff in their pursuit to improve literacy. They also have insight into the use of technology and professional development practices in which they both implement and partake.

5.7.1.1 LD Role: Undergraduate and Postgraduate student support

LD provides a range of services to all UOW enrolled undergraduate and postgraduate students, international and domestic. The services include workshops about academic writing, one-on-one sessions, mathematics support and special programs which include research writing. These programs are provided in areas of academic support that are required by students and have been developed over a period of time at UOW. LD conducts programs on the main campus and at the satellite campuses located at Batemans Bay, Bega, Shoalhaven, Southern Highlands (Moss Vale) and Southern Sydney (Loftus).

5.7.1.1.1 Workshops

Workshops are scheduled and delivered at various times during the semester. Some workshops are designed for international students, others for postgraduate students; others may address academic learning and literacy needs for all university students. Topics covered by workshops include essay writing and editing, report writing, thesis writing, reading for assignments, grammar, oral presentation skills and exam preparation. There are also thesis writing workshops which are provided for

[1] All names used are pseudonyms to protect the identity of participants

postgraduate research students which involve topics such as what is a thesis, planning research and writing a project, structure of a thesis, effective referencing, writing a thesis proposal and literature review, organising chapter and paragraph cohesion and developing critical argument.

5.7.1.1.2 Mathematics Literacy support

A mathematics learning development lecturer provides support for mathematics and statistical literacy. This appointment recognises that some students enter the university with backgrounds that do not prepare them for the mathematical and statistical requirements of their courses. For example, students may not have completed the Higher School Certificate Year 11 and Year 12 in mathematics and yet they might enter university enrolled into a commerce or science degree for which they need mathematics. Engineering students need higher levels of mathematics, so they require more support. Students who are enrolled in education degrees have to be very familiar with certain types of mathematics in order to teach at primary school. Students enrolled in nursing have to understand mathematical principles related to drug dosages. In 2011, the LD unit employed a mathematics support person. Participant Andrea noted:

> *A lecturer built up that position to largely focus on statistical education. and that led to a number of developments including statistical literacy for students and eventually led to the appointment of mathematical or statistical support staff for undergraduate students.*

Carol commented on the need for statistical support noting:

> *Many of my students are finding the maths quite difficult. Some students come to me and they want five minutes and we iron out a single problem. Some students come with a genuine anxiety and that will take a longer time to work out how to overcome their problems.*

Math anxiety can account to a medical disability. Andrea noted:

> *that disability might be that they have great levels of anxiety to the point that it is a medical difficulty and so they are provided with documentation for the university to say they have these high levels of anxiety around various things including mathematics. So we work as a support provider for those students.*

5.7.1.1.3 Consultation

Students may also attend individual consultations with LD staff enabling them to discuss how to improve their academic performance including assignment and thesis writing, research and critical reading, oral presentation strategies and English

language and grammar. Individual consultations are delivered weekly depending upon a student's available time and needs.

5.7.1.1.4 Provision of resources

LD also provides self access online based resources through the Unilearning website (http://unilearning.uow.edu.au/main.html) that any enrolled student can access to help practice and develop their skills. The resources support writing reports and essays, looking at critical reading, and all of the normal activities that LD supports. It is a valuable way of accessing academic help for students if they are off campus. For instance, students can post on a discussion site; this allows them to work in their own time.

5.7.1.2 LD Role: Academic staff support

Even though the main role for LD is focusing on providing learning support for students, they also influence faculty academics when they collaborate. For example, staff development opportunities are available for less experienced staff members which involve examining the aims of the subject, how they might deliver that subject, how they might evaluate what happened in the past and in the current semester. Staff Brenda notes how the negotiations occur,

> *A meeting a couple of times a session where all these tutors would get together and we'd have a forum like an open discussion. "what are the problems you are having" "how can we deal with this" and it was done in a democratic way, so one tutor might say "you know I had trouble contacting my student coordinator and so this is what I did and this is what worked for me, and some say well I have never seen mine, he or she is very good with email.*

Another example where LD can help is if a faculty staff member teaches a core first year subject that has a large cohort of international students for whom English is a foreign language. This staff member might require assistance in developing resources or working in terms of teaching the students' academic writing. The faculty staff member can involve LD in this process. One option is for LD staff to directly teach the students through the subject by taking some of the lectures to deliver the required academic language and literacy classes. Whilst the focus of these lectures or workshops is on students there is a professional development advantage for faculty staff who are part of this collaboration. Another result of the collaboration is the opportunity for faculty staff to think about teaching in different ways and to expand

their teaching repertoire and in this way to embed good teaching and learning practices into subjects. Participant Brenda, in the LD unit, supported this argument by saying,

> *We were focussing on assessment items for the students but what came out of it when we were writing a paper on it was that the subject coordinator said "I learnt so much about professional development by listening to the way you articulated the learning.*

On a satellite campus a tutor may require advice. Brenda notes,

> *They will come to me and say 'how can I do this better' or 'can you look at my practice and tell me where I can improve', that sort of thing.*

Discussions with lecturers are provided to understand how to make their teaching load easier to deal with. Brenda said,

> *Open conversation, a discussion so that a person feels comfortable and then opportunities arise and then you try not to be negative. Focus on the positive things that they do and then make suggestions for improvement rather than saying "you are a hopeless teacher / what you do is boring" you need to be doing new stuff". That does not work.*

This is supported by participant, Donna who indicated that,

> *I do participate in formal programs as well, but I find the most effective thing to do is go to where problems are occurring in teaching and learning, where they are not performing very well or there is some level of frustration either with the students or the teachers and really look at that situation carefully and together to workout solutions.*

One issue facing staff developers is the perception of faculty staff that they do not understand what any particular LD unit is for and why it can be helpful. Donna noted:

> *I think people have simple ideas about language development and language problems around students. They really would rather prefer to send to students away. They fear that working together will mean more work for them.*

5.7.1.3 Professional development of LD staff

Lecturers in the LD unit gain professional development in a variety of ways including reading, research, evaluation and publication. They attend mandatory professional development courses at UOW such as the University Learning and Teaching (ULT) course. In addition staff attend many professional development opportunities that exist in UOW and also those at others. There are many workshops, conferences, gatherings and opportunities for one–to-one consultation.

The staff development process in the LD unit involves group meetings every couple of months. In these meetings, a day is allocated to work with each other to examine the theory and practice of what they do, to see what each person is doing and also to learn from each other. The LD staff work from various theoretical bases, so these meetings allow staff to mutually support each other's professional development.

The LD unit does not have a formal plan for staff development. However, each staff member has their own career development plan and once a year that staff member has an interview with the head of the department to discuss what the staff member requires for their own personal and professional development. For instance, staff in LD can take study leave to undertake a particular project. This might involve working with staff from another university related to learning development. Andrea noted:

> *Every single staff member has their own career development and professional development plan on file and we review that annually. We see where they have been, where they are heading with it, what the unit can do to work with it, how it fits within the unit's plans and fits with the university's strategic directions.*

There are a number of committees that operate around educational policy and practice at UOW which provide important avenues for staff to collaborate. Donna noticed:

> *A very important strategy at this university is to get ourselves onto the appropriate committees so we will always have a voice and an opportunity to see what's going on to offer assistance where we know it's going to be needed. So not just waiting for a problem to happen but predicting and preventing one.*

As a result LD comes up with many improvements, some are small scale and others are large scale. Donna noted:

> *Sometimes it's a very simple thing or might be a really big curriculum development project that involves a lot more people as well.*

5.7.1.4 Technology use by LD staff

Technology can enhance teaching practices. Some LD staff use technology such as digital storytelling or blogging. Donna noted:

> *Technology such as digital storytelling or blogging is something I do a lot of or making posters digitally.*

For those at satellite campuses, video conference facilities are used which is an efficient use of the available technology. At satellite campuses students learn in a

multimedia and distributed learning environment. Staff members in the faculties are involved in the online delivery of subjects. LD staff have to be technologically skilled as they deliver lectures online and develop online resources.. They also need to access eLearning site to upload resources, such as, PowerPoint slides, work sheets, Wiki and discussion groups.

Whilst all LD staff have a computer on their desk, they have only recently had access to a SMART Board (an interactive whiteboard) in their teaching room. This is not linked to the satellite campuses. A SMART Board is particularly useful for teaching language because of the way it can be used to manipulate texts. However, Brenda noted:

> *Having a SMART Board does not mean that you cannot teach language in any other way. It enhances it. It helps you but it is not everything, sometimes there is a place for chalk and talk too. So that having the best PowerPoint presentation is not the only way to teach.*

Another advantage of using technology is resource development by using particular technologies such as Tablet PC and Camtasia Studio to produce video resources. Donna noted:

> *I have been able to apply some of that technology in the work I do. I have learnt how to use the tablets and to produce those sorts of resources in relation to teaching….. Making demonstration videos in particular when your telling students to do a certain task, developing a resource that shows them how to do that, instead of telling them to do it.*

The issue with the change of practices associated with the adaption of new technology is that it is time consuming for staff. Donna noted:

> *Sometimes when you have to learn something new, it's a lot of work when you're learning how to do digital stories or how to use digital demonstration resource videos or the blogging. Until you've done it a few times and worked out what is most effective. Yes, there is a big investment of time and effort at the beginning, but the payback is you get it right, it makes things a lot simpler and easier later on.*

5.7.2 Learning, Innovation, Facilities and Technologies

The Learning, Innovation, Facilities and Technologies (LIFT) unit is part of Academic Services Division (ASD) providing services, programs, products and resources that support UOW staff and students. One member of staff was interviewed from this unit. LIFT has responsibilities with respect to maintaining common teaching areas.

5.7.2.1 LIFT Role

One of the major roles of LIFT is to automate or simplify the use of technology in teaching spaces that staff use, for example by implementing push button control. Some staff are apprehensive about using technology because they have to deliver content and they must also perform in order to engage students. In addition, the teaching staff focus is almost always on their area of expertise rather than on how to teach and certainly not on how to teach with technology. So technology has to be very simple to use and the cognitive load must be low. Participant Xie articulated the importance of the ease of use of UOW technology:

> *From my point of view the goal at Wollongong for learning technology is to make it easier and easier and easier to operate, to increase levels of automation so that there is less for the academic to do, less for the student to do.*

5.7.2.1.1 Common Teaching Areas

Currently, there are two mechanisms for teaching with technology. Firstly, students on the central UOW campus are taught using technologies found in the lecture theatres and in the classrooms. Secondly, students at other campuses, such as, Shoalhaven, are taught use video conference in addition to local laboratories.

UOW has 144 rooms labelled as common teaching areas because they can be used for teaching any subject. There are other teaching rooms that are owned by faculties. For example, the Informatics Faculty owns some rooms in the mathematics department and consequently they can put whatever technology in these that they choose.

The common teaching rooms are classified into six categories according to the available technology:

- Category 1 rooms have an overhead projector, an old-fashioned technology which staff rarely use as the image is often too small and indistinct for teaching in the larger rooms.
- Category 2 rooms have an overhead projector to project from PCs or laptops plus a document camera, which can project illustrations from books, cartoons, diagrams and charts, photos, concept map etc. The document camera can also

be used also to capture images of small objects such as samples of rocks, chemicals, circuit boards or small demonstrations (Caladine, 2008). It is effortless and quick to project a text using a document camera onto the large screen so students can see a clear image. This would be useful for many subjects, in particular for mathematics, where subject symbols are used.

- Category 3, rooms have a data projector on the ceiling with a plug-in-point at a lectern for a laptop computer, a DVD player and are able to play VHS video tapes. The centre has obtained funding to equip all category three rooms with computers between 2012 and 2016. All the technology in category three rooms is operated by push button controls.
- Category 4 -5, rooms comprise large lecture theatres where there is a touch screen for lecturers to use. Often there are two display screens and two projectors so staff can project different images on different projectors. The touch screen is important because it makes using the technology very simple. Xie expressed the importance of ease of use of this equipment:

  > *One of the essential things in any educational technology is that it's got to be easy to use otherwise they won't use it because often academics are nervous about teaching.*

  Some classrooms and lecture theatres have interactive whiteboards (IWB) installed in those rooms whose size dictates that they are useful, and where students can see the board and staff can use them for interactive teaching.
- Category 6. There is one large lecture theatre, which accommodates 539 students. Power outlets built into the seats provide laptop recharging throughout the auditorium. Wireless networking is a feature of this theatre and its foyer, which has been reconfigured to provide informal study facilities for 32 students (FMD, 2012). (Wireless is available at all campuses).

In the mid year 2013 LIFT changed the six categories of rooms available in Common Teaching Areas to three categories (LIFT, 2013) (refer, Table 5.20).

Table 5.20 Audio Visual Facilities

Categories	**Audio Visual Facilities**
1	1. OHP, Screen, Projection and Laptop input.
2	1. OHP, Screen, Projection, Computer (PC) and Laptop input.
3	2. OHP, Screen, Projection, Computer (PC), Laptop input & Document Camera.

Tutorial/seminar rooms category (L-TUT), vary in capacity and spatial layout, equipment and special features The features of lecture theatres (L-TR L), lecture

theatre in a U shape (TR/U) or mini lecture theatres (L-MT) category also vary in capacity, equipment, spatial layout and special features (refer, Table 5.21).

Table 5.21 The features of L-TUT

Configuration	Explanation	Pictures
L-TUT	Tutorial / Seminar Rooms -Tables and Chairs **Capacity**: 20 Equipment: 1.OHP, Screen, Projection and Laptop input.	
	Tutorial / Seminar Rooms -Tables and Chairs **Capacity**: 20 Equipment: 1.OHP, Screen, Projection, Computer (PC) and Laptop input. Special features: Whiteboard room	
L-TR	Lecture theatre **Capacity:** 164 **Equipment:** 2.OHP, Screen, Projection, Computer (PC), Laptop input **Special features:** Hearing loop facility, Lecture Capture, Document Camera	
L-TR/U	Lecture theatre in a U shape **Capacity:** 98 **Equipment:** 2.OHP, Screen, Projection, Computer (PC), Laptop input **Special features:** Hearing Loop Facility, Video Conference, Document Camera	
L-MT	Mini lecture theatre **Capacity:** 48 **Equipment:** 1.OHP, Screen, Projection, Computer (PC) and Laptop input	

Table 5.22 The features of L-TR L, TR/U or L-MT

* Source: http://www.uow.edu.au/asd/lift/teachingspace/index.html

5.7.2.1.2 Other technologies are used for UOW

The main technology experienced by students at UOW is the learning management system. This is managed through the Centre for Academic Systems and Resources (CASR). The learning management system is a place to facilitate blended learning, the system for the most part complementing face-to-face teaching.

The satellite campuses use two other technologies eduStream and video conferencing, in addition to interactive whiteboards (IWB). Most staff choose whether they will use eduStream. In some cases academic staff must use videoconference when delivering their subjects to other locations. As Xie declared:

> *If their boss says to them "We are going to send this subject to Nowra and Batemans Bay and Bega", you're going to need to use some of those technologies to get there.*

Due to the variety of technology it can be confusing for a lecturer as to what to choose. Instructional designers can assist the lecturer to pick the most appropriate technology for their particular subject. Xie reported:

> *In the "Learning Activities Model" these are the categories of things that teachers and students do for teaching and learning. The provision of material is the content; interaction with the content includes online or textbooks or whatever; interaction with the teacher and interaction with other students. They read the books, they read the notes, and they watch the videos then none of the above.*

5.7.2.1.3 eduStream

eduStream is the system used to give students access to recorded lecturers and other learning materials on the Internet. eduStream started in 2003. It is used for some students at the central campus and all students at other locations. The aims of the eduStream are to enhance student learning experiences and to extend the ability of the UOW to offer rich learning experiences. eduStream, which delivers podcasts, vodcasts and streams, is a bonus at the central campus but essential at the satellite campuses. eduStream is used for students so they have a record of the lecture for example, as Xie reported:

> *The School of Nursing were the first users of eduStream the primary way that students receive the learning materials provided in the lectures. These students heavily depend upon eduStream as a critical learning resource. It also allows students at other locations to hear what happened at a lecture at the main campus.*

The benefits of eduStream are not only is the lecture captured and heard but also that it can be replayed. This provides an opportunity for deeper learning, for better note taking. If students miss anything in the lecture, they can replay it for greater understanding and also become more familiar with the language. This is supported by outcomes evidenced in a survey of students (Copley, 2007) that supplementary lecture materials, such as audio and video podcasts, facilitate better revision and preparation for assessments, allowing students to engage with concepts during lectures rather than note-taking and providing opportunities for students to assimilate complex information at their own pace. Fardon (2003) has expressed the view that for students whose learning style does not match a traditional lecture well, the lecture recordings would appear to offer great value and flexibility. Moreover, this technology can benefit and enhance learning for students with disabilities or international students whose first language is not that of lecturer (refer, Section 2.3.5.2). Although staff are not forced to use eduStream, there remain many staff who are reluctant to use it. As Xie noticed:

> *I find someone that says "Oh no. That's going to conflict with the way I like to teach" .... A lecturer believes very much in a student centred learning approach; believes very much in an interactive learning experience, was told he had to use eduStream because the subject he was teaching, the course, was now going to be offered to students in other places. And he came to me and he said "Look I've got awards for teaching and it's because of my philosophy of teaching and learning" and I said "Yes that's not dissimilar to my philosophy of teaching and learning" and he said "But how can you use eduStream? How can you be the manager of eduStream?" I said "Ah, there are some areas where eduStream is appropriate. Now the first thing you need to do is to forget the idea of the one hour lecture. Tell me about your lectures." He said to me "Oh, we don't really have lectures." "What do you do?" "Well, I'll talk about a topic and then we'll discuss it"; the same, exactly. So you capture in eduStream that bit of talking, it might be five minutes. There's no law that says it's got to be an hour long. You can have 5 minutes. I said "How often would you do that in a lecture?" he said "Maybe 3 or 4 times." "OK, capture them as separate modules and, by the way, we can do that before the lecture if you want. So that you can actually sit in the studio and we can make a really polished presentation of it and then for your students down the coast, for the interactive part, we've got video conference". He said "oh, oh, in that case I'd like to do it" and seeing we're going to a bit of trouble to record these 5 minute modules to eduStream, why not use that for your Wollongong students as well. Then they can listen to it before the lecture and you don't have to spend that time in your lecture theatre. You can have all the time in the lecture for interaction.*

This is a good example because the discussion focused at first on the delivery of eduStream. With discussion the lecturer was able to see how technology allowed teaching to become more interactive. Prior to using eduStream video recordings, printed material and video conferences were used. Caladine (2008) points out that eduStream can provide:

- An audio or video recording of a lecture, which students can access as many times as they need during the session
- A video recording from a document camera
- Recording of resources for podcasting or streaming
- Recording of video conferences
- PowerPoint slides from lectures

eduStream is an automated system, which means lecturers do not have to do anything. It is provided in approximately thirty-nine lecture theatres. As Xie reported:

> *It is possible to record in rooms that are not equipped with eduStream by giving staff a portable recorder. When using eduStream the lecturer enters the room, turns the microphone on and at the end of the class turns the microphone off. In rooms where eduStream is not installed the learning technologies officer will then upload the recording to the subjects into eLearning site. In equipped rooms the recordings are automatically processed and accessed from a link in the LMS.*

The recording part for the lecturer is simple and easy to use, but a technical officer handles the uploading process. As the Xie noticed:

> *A lot of vendors have come to me and said "Look we've got a great product. All they've got to do is press this button." See the current product, which is out of date now, they don't have to do that.*

In 2012/2013 eduStream was upgraded from the Lectopia technology to Echo360 as the vendor discontinued Lectopia . Echo360 is an improvement on Lectopia for many reasons as Xie reported:

> *Firstly, the standard is now a video of the presenter plus video of what is on the screen. In addition, the images from the screen are synchronised with the audio and video. Moreover, the text on the screen is searchable and students may employ navigational aids such as bookmarks and thumbnails.*

Echo360 was trialled in Spring Session 2012 and used as the default technology for

eduStream from Autumn Session 2013. The advantage with this system is that it allows screen capture and teamed with Tablet PCs is very useful for capturing live worked solutions. This unit also has a video production group to edit videos and make video clips for teaching and learning. Further it has a hearing loop that enables the hearing impaired to receive sound through a hearing aid.

5.7.2.1.4 Video conference

Video conference is a technology that allows two-way video and audio communication between remote parties (points/endpoints) (Caladine, 2008). Video conference is a large part of UOW operations. There can be up to five or six video conferences happening simultaneously. Often it is used to connect students at Wollongong with students at other locations, such as, Shoalhaven, Batemans Bay, Bega, Southern Highlands and Loftus. There is also a connection with Newcastle University and with the University of Sydney for medical students. As the Xie noticed;

> *Some medical students who are on placement for their course are as far west as Broken Hill, which is near the South Australian border. All of these students need to be able to connect to the UOW on one day of the week when they have a full day of classes. These students use a video conference, some of those video conference endpoints come through the University of Sydney and then onto Wollongong. Video conferences are also used to connect to people in other location such as experts presenting to a class or students in other countries.*

Video communications are significant for two reasons. Firstly, people get used to their own image and communicating this way which allows for eye contact. Secondly the viewer is able to join a video conference from other locations. Networked interactive whiteboards are being included within video conference rooms. As the Xie noticed:

> *Students can use the video conference to see each other, and to hear and speak to each other and to interact via the IWB.*

Although video conferences presentations are effective, the professional development is required. As the Xie noticed:

> *Video conferences presentations are more effective if lecturers are broken up with interactive sessions which are necessary if students change their cognitive processes from passive reception. However, lecturers need support and be well prepared for video conference. They need to plan a variety of activities and use a variety of different inputs including the document camera, main camera, video sources and computer.*

Caladine (2008), a UOW staff member, discusses different elements that lecturers can used with video conference such as opening interactions, closing interaction, student led discussions, group discussions, presentations, questions and answer sessions, demonstrations, individual and group projects.

5.7.2.1.5 Interactive whiteboards (IWB)

In mathematics teaching via IWB allows staff and students to work on the same problem. By using virtual technology, students in geographically separated locations can collaborate to work on the same problem. In mathematics, the development of the solution and the discussion are as important as the solution. Having students participating in developing a solution is a beneficial and valuable way to involve students to think about the steps involved in developing solutions. Through the use of an IWB students feel that they are working on the same problem and interact in the virtual space, in a similar way to interacting in a physical classroom; this promotes both teaching and learning.

Therefore a device which allows students to communicate in this way is a positive addition to learning. As the Xie noticed:

> *A multiple conference unit, or a bridge, is important technology that needs to be further improved in two ways. It must require less in technology knowledge from both the students and the teachers and it needs to be more reliable*

5.7.2.2 LIFT: Support and training of academic staff

All new academic staff commencing employment at UOW are required to complete a formal education training qualification if they have had not had formal training in education which include technology. This training contains module on eduStream and on video conferences where the theoretical basis and the appropriate use of the technology in depth are explored. In order to encourage staff to use technology appropriately it is important to design the training activity to fit the staff profile. Training must also be as accessible as possible as many staff are time poor. As Xie noted:

> *Years ago you could get people to come to training sessions quite easily. These days it's more like 8 People because people are busy.*

Outside of formal education training qualification, staff development is performed by the trainer through two types of activity. Firstly, there are one hour formal staff

development events. Events include face-to-face, or the equivalent, training sessions which include drop-in sessions, one-to-one consultations and group sessions. There are many different types of face-to-face sessions. As Xie observed:

> *Drop-ins are great because, you are not saying "You have to be there for the whole hour'. So people feel that they can do that whereas if you say "I want you to come and devote an hour of your time" they'll be like "Oh no I can't do that. Again it's making it fit them.*

Training is sometimes provided in a faculty. All new subject proposals are required to identify whether technology is required to teach it. Training sessions can then be offered if necessary. As Xie noted:

> *I say "engineering is going to offer a new degree to students at other locations. They are going to need eduStream. I'd better get onto the Sub-Dean for Teaching and Learning in Engineering and say hey how about we get the key people together and run a session for them." Now that won't be just on eduStream, it would be on everything probably. And I would start with the theoretical basis which I'll come to in a moment, which you've already seen if you've had a look at that book. The other thing is that when people fill in the form to use eduStream, which is an online form.*

Secondly, for those who cannot access face- to-face sessions there are alternative online training resources they can access. The centre produces print resources which are available to all staff, so that if the staff member cannot attend to a face-to-face session, or does not want to, they can take those away. These are also, or will soon be, available on the web. These documents all have a page called "The least you need to know". Resources are also supported by a variety of contact details including phone numbers, email addresses, web URLs and websites allowing academics to explore further according to their expertise. In addition they also can arrange to meet the trainer face-to-face. As Xie commented:

> *Show them, during that half an hour, show them how to do the basic functions on eduStream, including things like putting in some annotation so students get a little bit more than just the recording, some metadata that might be useful to them, show them how, if they use PowerPoint slides, how they can upload those slides to the eduStream PowerPoint slide converter.*

5.7.2.3 LIFT Challenges

There are many challenges facing this unit in terms of providing professional development. The challenge is not only providing professional development to academic staff that need it, but in educating academic staff who do not realize that they need it. Academic staff may fail to consider that the use of new technology

requires training. At UOW as found elsewhere many teaching academics are unfamiliar with the possibilities of ICTs and have limited understanding of how to integrate them into their teaching in pedagogically appropriate ways (Brack et al., 2005). The reason for this, could be a consequence of the culture of teaching and learning at universities in Australia, where teaching is seen as secondary to research (Brew, 2010) even though it is important for universities to integrate research and teaching (Brew, 2010). Staff know that promotion at UOW, as indeed most Australian universities, is biased towards research performance. As Xie noted:

> *There are a few people around this place, who believe that teaching and learning is as important as research or more so but most, let's say a lot, believe that research is the most important thing and teaching and learning is something I have to do. So getting them to invest time and energy in teaching and learning is hard.*

Academics coming to the scholarship of teaching and learning need to have an understanding of how ideas in the field of higher education have developed. This is especially true when publishing, but it is also the case when developing new teaching initiatives (Brew, 2011). Research-enhanced learning and teaching is a strategy to meet the needs of students in the twenty-first century (Brew, 2010). University staff may recognize that teaching and learning could be better, but they need to look at funding as Xie noted:

> *Let's look at attracting funding for teaching and learning. So we went to the Australian Learning and Teaching Council. Oh yes there are grants there. You can get a research grant to research your teaching and learning. Ah now this counts towards my promotion at the University of Wollongong but it's teaching and learning.*

Even though the university is a learning institution where both research and teaching activity are important, there is a greater emphasis on research than on teaching. Therefore, the university is looking for financial support through research.

5.7.3 Professional & Organisational Development Services: Role

Professional & Organisational Development Services (PODS) offers a variety of career and professional development activities for both academic and general staff through an annual training calendar. The aim of these activities is to achieve short and long term goals and objectives as well as to enhance staff member or team knowledge, skills and attitudes relevant to their current work or to future roles (PODS Policy, 2010). Four staff members were interviewed from PODS. Participant

Eric, who worked on the implementation of a new human resources software system for the University, described the role:

> *Our team conducts a range of different types of training and development programs. Some would be straight-forward workshops – it might be a course in teaching people in time management, customer service skills, or how to recruit and select people for jobs in the University.*

Professional and career development is the responsibility of the organisation, managers and supervisors, and individual staff. PODS provides support to do this. Responsibilities of the organisation includes provision of advice, support and guidance for ongoing change initiatives, to provide internal professional development opportunities that meet the University's Strategic Plan and to provide support and leadership development opportunities for all staff (PODS Policy, 2010). The responsibilities of managers, supervisors and staff include to:

- Ensure that all staff (general/academic) receive appropriate initial training and induction;
- Assist staff members (general/academic) to develop their performance, both in their current role and in meeting the changing requirements of their role, in order to contribute effectively to their unit or divisional plan;
- Assist staff members (general/academic) to regularly define, develop and refine their career goals, skills, attributes and responsibilities (career planning);
- Identify group/team development needs;
- Evaluate the effectiveness of training and development undertaken by staff (general/academic); and,
- Conduct annual Performance Planner/Agreement (General Staff) or Performance Enhancement and Career Development Record (Academic Staff) discussions with staff (PODS Policy, 2010).

PODS is also responsible for the maintenance and retention of centralised UOW training records and assisting with the coordination of training courses (WHS Training Guidelines, 2013).

PODS is responsible for the professional development of the University's academic and research staff in relation to accessing data and using the student management program (SMP). The UOW data warehouse and performance management system is a web-based system that staff can access to analyse data and access reports and

information about students, research and finances of the University. Not all academic staff have access to SMP and where they do have access there is a different level of access according to staff responsibility. As participant Graham noted:

> *It requires a lot of business process change. It means people need to self review their processes and collectively make decisions on how to improve that process and go ahead and make those changes and train people to make those changes …… So if any staff leave the University the next staff member who came in would be able to go somewhere to see that is what they had to do*

There are PODs courses that target new employees and provided training for new supervisors who have minimal experience in managing staff. These are aimed at enhancing the ability to meet University strategic goals (PODS Policy, 2010). From the University's point-of-view PODS helps staff (general/academic) to perform the best job they can for the University, so that they work effectively and efficiently in their role. However, from an individual point-of-view such measures should also enrich a career providing more user satisfaction and better equipping staff (general/academic) to approach different roles. As Eric noted:

> *perhaps a promotion for a higher role so they are equipped to advance their careers.*

An aim is to develop both individuals and teams within the organisation in order to meet strategic goals, to help strengthen their capacity to learn and to grow and also to develop leadership capabilities (PODS Policy, 2010). As participant Harry noted:

> *we want to maximise peoples' potential, so they are continually growing and developing the skills related to their position and the needs of the University.*

Another aim is to develop an analytic culture among users of the system. Training for this aim focuses first on how to use a tool, then on how to move towards understanding the data as the basis for decision making. As Graham noted:

> *so when they make a business decision, the first thing they need to do is have a look at the data. If they consider that in the decision making it is helping to build that analytic culture*

PODS also aims to provide a supportive climate with an open communication style that encourages participation of staff and management in the design and revision of organisational, professional and career development systems to increased capacity of staff to initiate and respond constructively to change and to enhanced team effectiveness and productivity (PODS Policy, 2010).

PODS have established mentoring programs including individual mentoring

partnerships and also provide online training programs. Staff are not compelled to attend training though PODS recommends that all staff attend induction training courses. For example, Workplace and Safety training is important for all staff.

5.7.3.1 Training workshops

PODS offers a range of training workshops covering key areas for new staff organisational knowledge, research development, planning and review, workplace health & safety, career development and progression, professional development, finance courses and leadership and management development. In addition to information technology courses, there are information literacy courses (library), student systems training and statistics, team building, supervisory skills, customer service and one-to-one coaching for staff. There is project-based training and every project they deliver has a training component and seminar launches associated with that.

The first workshop of training covers what is PODS, what do they do, how they support staff and where to find help documentation. One of the exercises is to go and find a particular document on the website. In some cases it is recommended that staff do not attend introductory courses but rather engage in one-to-one with a trainer at their desk for 30 to 45 minutes. Then they may be enrolled in a second level course. It is important to cater to different skills and levels.

PODS staff use the data for a variety of reasons include to help with analyses and to support early intervention for students, or to support developing a marketing strategy. A thirty-minute briefing session was introduced in 2011, followed by an introduction to the system, an introduction to advanced skills and then to understand data flows. Briefing sessions are information only sessions, explaining initiatives or activities on how to use student data or on how to use the system. Graham gives an example of this:

> *So may I ask how are my first year students doing, compared with my second year students? We would run a specific course on what data is available to answer that question and how the staff member would use it.*
>
> *If you want to know how they are performing in terms of their marks compared to students who are not in their first year but who did that subject, you can look at this data set to identify that. If you want identify where your 'at risk' students are at and if they are not performing well, and who may be starting to*

> *disengage from the university, this is the data set you would go to and this is how you'd identify those students.*

At the end of the briefing if an academic member of staff, chooses to stay, they have the option to discuss additional details or to discuss the way that they could use their data for particular purposes. The PODS instructor can tailor their instruction for a particular individual.

The workshop, following the briefing, is an introduction to the system that lasts for ninety minutes. This is available to any member of staff that nominates. Subsequently there is a follow up course on more advanced skills delivered to groups of up to ten staff every two to three months. Following these are new courses that each last for two hours. The first of these is about how to better understand the data, i.e. the business rules and logic. The second of these is how the data from a student's application flows through various systems and can be converted into data that the user can download. As Graham noted:

> *so it is educating them about data quality issues, how they may want to use the data, what the data really means, have they any logic and assumptions about the data that they aren't aware of before they use it.*

The role of PODS is not just to educate participants on how to use a piece of software, but on how to integrate the outcomes from that software into their career. As Graham noted:

> *I think from a IT perspective it is very easy to deliver courses that help people use the technology but not how to apply that technology. We have put two new courses together this year in how to apply the technology.*

These sessions are always delivered around lunchtime, and are flexible in an effort to fit within staff needs. As a Graham noted:

> *we pick a topic that we can work with and then we have a half hour seminar on that topic. At the end of that seminar we have half an hour where people can stay back to ask more questions and we will work with them to implement that back into their own work.*

There are other introductory courses drawing staff from divisions and faculties across the University. An example of such a course is 'curriculum review'. The University has an academic process whereby, on a regular basis, each subject is reviewed to ensure that it is producing the expected student outcomes. These outcomes need to be aligned with what is happening in the broader world. Graham noted:

The University would like to see as part of that academic review that they also look at the data that pertains to that course. That they look at how the students are performing in that course. Are students interested in that course? What type of students, do or don't get into that course? What kind of progress do the students in that particular course make? How do current and historical students who have done the course perform both now and in the future and during the course. That information is used to help facilitate curriculum review… Academic outcomes … get considered in the curriculum review process.

What we've been able to do is develop, with the people who are responsible for that process, a set of reports that allow those who are participating in that review to go easily to see what information is available to support that review.

We have been able to integrate that into the procedure associated with it, then train people on it and that helps to embed it.

5.7.3.2 PODS consultancies

PODS work as required on tailored consultancies for individual faculties. For example, they facilitate an annual planning day for the Research Services Office. They also administer a range of development policies that provide staff with study time, postgraduate sponsorship and study allowance. There is a development program that allows PODS staff to visit other organisations and provides funding. Eric noted:

I think the most effective intervention in our organisation is where we have a tailored intervention with a faculty. It might be the Faculty of Science where they are having some issues with team dynamics and they want us to come in and sit down with them and guide them through a process where the team better understand how they work together, and come up with some agreed paradigms on how they'll exist. That sort of area is our biggest impact in terms of actually helping people to change and grow and really benefit.

PODS consultancy service, provides customised training or facilitation to faculties, departments and work groups. PODS provide access to formal mentoring and coaching programs as well as a range of resources. Qualified internal coaches are available to provide one-to-one professional development support. Eric noted:

A lot of our development activities are what I call 'tailored', where we act as an internal consultant to faculties and divisions. They may come to us with a specific need – it might be they have some restructuring going on and they want to us to tailor the program which helps with team building and change management.

5.7.3.3 Strategies for training delivery

There are three main strategies for training delivery which cater for the different levels of the organisation and for different needs. These are required because staff have a diverse range of requirements at different points in their learning cycle which may also be dependent on their role. As Graham noted:

> *Some people aren't comfortable in the classroom, they want a one-on-one. Some people don't have time. Others can't afford a large gap in their diary so they will have lots of small stages. We believe the training works more effectively when the subject is really relevant. So when somebody is asked to produce a report, or to get some data and analyse it, they are going to learn much better if they've got a business reason to engage with us.*

These strategies are scheduled training, customised training and one-to-one training. For scheduled training PODS uses different methods to inform staff about training opportunities. For instance, staff can access the calendar online and nominate a program based on what they desire to do. Email invitations are sent out to remind staff when courses are scheduled in the next four weeks.

A customised course might run for users who have been identified as needing a particular set of information. In the case of one-to-one training, trainers visit the staff offices at a time that suits that particular person. As Graham noted:

> *The instructor goes through some contents slides, demonstrates the product and then we get the users to do various exercises on what gets demonstrated. Then at the end of the lesson there is a workshop where from end to end they have to solve a business problem we pose to them using all the techniques they've learnt in the various exercises. They get an opportunity to reflect on what they have learnt in the course and how to apply it in a logical business context.*

PODS, tends to focus more on group training because, from their perspective, it is a more efficient method. However, in instances where academic staff are not able to attend group training they may undertake small group training or alternatively an individual session. The more effective method is for users to sit in front of a PC and to use a system to do exactly what the facilitator needs them to do, having an opportunity to ask questions. At times an external expert may be called upon to insure that individuals have the skills and knowledge and are capable of using the system. As a participant Frank noted:

> *We are trying to keep people across what we're doing throughout the process. As much as possible trying to get feedback throughout the process and working with all our stakeholders to try and make sure that what we're delivering is*

going to work for them as well.

There is also published information on a website, which users can access for themselves. As a participant Frank said:

It's more when we see an opportunity we'll take it and help to develop some of our staff.

The most important strategy from PODS perspective is communication. PODS staff are aiming to communicate higher skill sets following the latest trends within each individual area. Courses are scheduled through development program initiatives at UOW. PODS staff conduct training through video conferencing with satellite campuses. Some programs, such as researcher programs and the leadership program, are designed specifically for academics. As a participant, Harry, who works at professional and organizational development services at UOW noted

Academics can do all of our programs. However, the two areas specific to them are research programs and leadership program. Only academics attend those programs.

PODS tries to change practices associated with technologies. For example, a staff system (CareerNet) is provided as a fully functional online system. It helps staff with online performance planning processes where they discuss annual goals. In this system, staff formulate annual performance review goals and development needs. Previously a paper based system was used which has now transitioned into the online environment, although, the process remains the same. As a second example, one PODS member is currently exploring presenting small online modules with a short video that PODS made for casual tutors. This is part of an induction program, which in the past has involved staff attending a two-hour session. This was not stimulating for the audience. As Eric noted:

Now we are looking at how we can do that in a different way using some online content …. It's more of a blended learning: some online and some face to face which I think is a good way to go

5.7.3.4 Staff development process and method

The staff development process for training courses is delivered using presentations, demonstrations and hands on activities, and requires reflection on each activity before moving onto the next step. Feedback is important for the trainers because this allows them to know whether the course is meeting staff needs.

Sometimes training starts with a “training needs analyses” which involve consulting with staff in different faculties and divisions and formally requesting what their needs are or a specific needs analysis that may be carried out on a particular area. As participant Harry noted:

> *Last year we concentrated on what researchers needed and then devised a program around that. So there is no real theory that we use.*

Once the training needs are clarified, PODS will establish the best way of meeting this need. The training could be provided in a one-day workshop, a series of workshops, or delivered online.

The process of determining individual or organisational training and development needs occurs on both an annual and an ongoing basis. At the PODS planning day data is collected and analysed to determine the training and organisational initiatives for the next year. Throughout the year other needs may be identified through discussion with divisions or faculties and provided to assist them with immediate issues. Training needs identified throughout the year are discussed at PODS team meetings under a standing agenda item. PODS also works with other training providers on campus to assist in meeting training and development needs and providing them with relevant information that is collected through the above processes. There are four key components to the training needs analysis process: to collect information, to analyse information, to respond to information and to evaluate and improve response. As Eric noted:

> *So we do a fair bit of evaluation of our programs to make sure the course you have come to you enjoy and you’ve got what you are looking for out of it and if not how we would look at doing it differently.*

Courses are delivered by PODS team members or by external providers with specialist expertise in their field. PODS staff are available by consultation or email to discuss needs with any unit and work as facilitators to help guide staff through these processes. These activities are conducted on campus by facilitators who are familiar with the university environment and work with staff to develop a program which is tailored to their individual needs. PODS maintain a library of resources on a wide range of development issues and these are available for loan to UOW staff members. As Eric noted:

> *We may do one-on-one training or development activities where we might have someone that needs specific coaching in a particular area. It could be career*

development so they are looking for a change in their career but they are not sure actually where they are going.

5.7.3.5 PODS staff professional development

PODS staff attend training and conferences to keep abreast of new trends in their area of interest and to gain more experience. PODS staff have their own mailing lists to distribute information.

The University has a strategic plan and staff have own their enabling plan. It is a two way process with a focus on both research and developing research skills. As Harry noted:

> *The components are about focusing on what the University's strategic plans are and we address that. This year we're concentrating on a lot of our programs on early career researchers and we also have two main leadership programs going and a mentoring program.*

5.7.3.6 Evaluation

Evaluation forms are collected every time training is conducted. Eric noted:

> *We take a lot of time to listen to our staff and make sure what we are delivering is what they need. We are responsive to feedback in our programs – if things need changing then we'll do that. As I have already stated we are constantly looking and listening for expressed needs for different things that we might not already be offering.*

On the evaluation sheet there is a place where other types of training can be requested. As Eric noted:

> *We are trying to be always aware of what our clients' needs are and to deliver those in a timely fashion*

Staff can register on the web and say what their motivations are for attending training course and what they hope to get out of it in advance. Such information helps PODS deliver quality professional development. Further not only are workshops evaluated but the PODS policy is evaluated to determine effectiveness/outcomes of the organisational and professional development initiatives as well as to identify improvements and drive continuous improvement (PODS Policy, 2010).

5.7.3.7 Challenges

Challenges facing staff developers in PODS involve time, resources and the correct people being sent to carry out particular training. Sustainability of resources and training is difficult because developing the materials, preparing the courses and

delivering are time consuming. As a participant Frank noted:

> *Sometimes people just don't have the skill set required or alternatively they don't have the time to get up to speed.*

Other issues include funding, having sufficient resources in terms of budgeting restraints and staff to develop and run programs. As Eric noted:

> *The list of what I would like to do is longer than the things we can actually manage. In this organisation this particular unit has a good reputation and we need to work hard to maintain that. We need to continue to be seen as being effective and useful to the organisation*

In addition, academic or general staff do not always have the time to attend programs. Another issue is the diversity of the work force at the University. As Harry noted:

> *We have landscape gardeners to top notch business managers within the faculty. The range of professions and skills required across the campuses are very diverse and is difficult for us to manage and we cannot do everything for every person.*
>
> *The engagement of our staff in our program in the University is very high. We don't have to cancel any programs. We have a wait list for them ...people asking 'where is it?' We have high attendance and engagements in our programs.*

Graham noted:

> *We have a number of issues, one of which is staff finding the time to attend to these things. Another is that we could run another fifty training courses to get a holistic view of what we do, but we have to be careful not to overload people too quickly and inundate them with training. So it's a difficult balance between expanding their knowledge and not running too much. Also people here are very busy so we have to make sure that the training is really, really worthwhile when they do attend.*

Another challenge is the engagement of staff in programs. This may be because academics schedules make it difficult for them to attend classroom training at scheduled times. Offering one-to-one services aids professional development in this area. Another challenge is to keep users engaged with the changing technology base through variations of training in offerings over time. Customised courses need to be made available to enable existing users to gain a skill set with enough knowledge so that they feel comfortable when software is upgraded or new technology is released in the system.

5.7.4 The Centre for Academic Development Services

The Academic Services Division (ASD) explores the needs of staff and students regarding teaching and learning. One member of staff was interviewed from this unit. The Academic Services Division's (ASD) has the responsibility to support and share with staff innovation and good practice in learning and teaching and to facilitate pedagogical design for collaborative learning. The ASD also encourages scholarship and leadership in curriculum, policy, technology, and key issues in the higher education sector. To achieve these activities, which focus on research-informed change in academic practice, the ASD support academic staff through consulting, collaborating, advising, designing, researching, evaluating, sharing and reflecting (Academic Development Unit, 2013).

The ASD works on strategic projects to develop policy at UOW. The ASD is interested in how academics can modify their teaching practices so that student learning is incorporated into what they do. This unit focuses on both deliberations about policy issues as well as teaching issues. For example, they may visit a faculty and have a workshop, or consultation, on what academics think should happen with teaching or teaching development. They then qualitatively analyse the proceedings of the workshop, feeding the outcomes into policy development and planning at the University. This can help academics develop teaching and learning policies.

The ASD also works on strategic teaching and learning projects and how academics can change their practice. The ASD consults with staff on both a faculty and a group basis on issues such as English language proficiency and first year teaching mode and how this can be improved. The ASD collaborate with staff to create programs to assist student learning. The ASD staff interview academic staff who teach first year lecturers as to how they go about their teaching and how they inform students about the expectations of the discipline. Staff generally are collaborative and engaging when ASD request an interview. As participant Tony noted:

> *They seem to be quite willing to do that so they're a fairly teaching orientated sort of people. There's quite a lot of enthusiasm.*

This tangentially touches on how academics teach and how they can integrate language development into teaching for domestic and international students. As Tony stated:

I'll be using that because I find that we are doing a lot of innovative things with first year teaching and I think we just need to share our experience more across the faculties and that might lead to some staff development tangentially

This helps the University to develop policies and plans which assist in this area. The ASD also coordinate and facilitate professional development for UOW academic staff through the University and the Teaching and Learning (ULT) course. Further, the ASD support all teaching staff to improve their teaching through additional workshops. Each year they present a program of courses, workshops, seminars, symposiums and information sessions. Faculty-based workshops, courses and seminars are designed and presented according to needs determined in conjunction with Faculty Education Committees. Professional development calendar topics are available on request. Teaching staff can select from the range of topics listed. Some of these workshops can be delivered on request and others are modified to faculty or group needs (Academic Services Division, 2013).

5.7.4.1 Professional development plan and processes

The professional development plan for this unit depends on determining needs and what is to be achieved. Information, both visual and oral, and activities are provided to the lecturers. As a participant Susan affirmed:

Is it something that it requires a resource to give to people? Is it a seminar or a discussion? What is it that they want? Maybe they should work with a colleague to observe each other teaching and give feedback. It is to think about why you are doing something in the first place. I think that is part of the strategy.

Many DVDs and packages have been developed to provide training materials. DVDs are good for training purposes. The participant had also used a video that demonstrates mathematics teaching, which the viewer can consider and discuss. Video resources have also been developed in the form of packages to train demonstrators in a science laboratory on how to be a good demonstrator. As Susan noted:

For physics the first year lab co-ordinator is now using it to train the new physic demonstrators every year.

If a resource based learning package is made available as a DVD and an individual or group views it without a facilitator then Susan believes that there is a need for a well designed handbook to explain how to use the video and to provide some key

questions and written information. Susan noted:

> *Some mathematics staff have come through that particular course, and found it very effective. There is one mathematics staff member who I took a DVD of, demonstrating how to teach in some ways of mathematics. She was always a good maths teacher.*

Professional development of academic staff involves developing and running many in-service lectures which explain how to give subjects, run a tutorial, how to be an effective educator of university students and how to be a better teacher. As Susan pointed out:

> *The student evaluation process is the key to my improvement in my learning and development. I got really good responses. I had the workshops and subjects I've taught evaluated. I got really high scores on those.*

The interviewed participant had co-ordinated the University's teaching course (ULT). The course is generic and not specific for a particular faculty teaching role. As Susan commented:

> *I would say, you have come to a generic course, so what you need to do is consider everything we say and offer you, in terms of your own process, so if you think it doesn't work, then you need to think why it doesn't and what is about your teaching. Have this discussion with your colleagues and us.*

One course demonstrates how to use video conferencing as a teaching strategy for students at a distance. As Susan mentioned,

> *It is not difficult to do, but it needs a little training. It is worth having a video workshop.*

Part of ULT is a peer observation process, where academics work with colleagues to watch each other teach by attending to each other's classes. As Susan indicated:

> *Staff can say, when I observed your teaching this is the plan you have for your class. You said in your plan that you wanted to get the students to learn this & that. And this is what you have done in the class. How does what you wanted the class to learn and what you have done fit together?*

This is considered imperative, particularly for staff from different cultures. For example, some of the Chinese lecturers in UOW have found the peer observation program very helpful. This is because it allow lecturers to watch their colleagues teach and to have ideas and confidence about their own teaching. Susan noted,

> *One said "I know how to teach in China, but I am unsure how to teach here." Being able to observe, they picked up some ideas from the Australian teachers and reaffirmed aspects of their own teaching- it gave them confidence.*

Academic staff can continue to develop their teaching by working with a colleague for long term support and guidance. This helps them to build their own sense of professionalism, supporting them in the self-understanding that teaching is a developmental process that never ends. This is a very effective way to improve face-to-face teaching and, at the same time, to build both collaboration and conversations about teaching within the department.

The scholarship of teaching is important, it is not just about knowing how to teach and knowing how students learn but it is also about sharing information and knowledge with colleagues and doing one's own research.

Susan found that in workshops experiential learning is indispensable. Staff explained experiential learning as allowing students to work on some examples such as stories, ideas or research. After the students tried to understand it, staff explain the theory. In this way theory is built on some prior understanding that the students have developed. As Susan noted:

> *I would try to give the staff some examples or activities to discuss the theory. What does this case suggest? What does theory relate to?*

Experiential learning might be the opposite of what many academics practice. Students are given the theory by the lecturer, and then they have a tutorial in which they work or apply the theory and obtain practice in using it from examples.

5.7.4.2 Challenges

There are many issues facing staff developers such as time and sustainability. The engagement of staff in programs has changed over the years. The UTL course was introduced in 1992. Through the University Academic Staff Association a contractual agreement made the course compulsory for all new academic staff. UOW was the first university in Australia to introduce such a course. The main difficulty associated with ULT is new academic staff are supposed to be given time release to attend.

Many academics are concerned with the quality of education, in particular the change of practices associated with the adaption of new technologies. As Susan noted,

> *Staff think delivery means you give something to somebody; education means interactions. It is not a transmission.*

Awareness about other cultures and an understanding of cultural differences are important at UOW. There is one workshop that explores notions of stereotyping about different cultures. As Susan noted,

> *There were always people from different cultures. Having them discuss the differences and similarities between, across and within the cultures and then focusing on the differences leads to building awareness and the knowledge that there is no reason to consider that learning is going to be any different wherever you go*

5.7.5 Centre for Educational Development, Innovation and Recognition

CEDiR seeks to support professional learning at UOW, to support leadership and to promote the sharing of scholarly learning and teaching practice. CEDiR has focused on teaching, which comprises many programs, activities and resources which are shared with academic staff (http://www.uow.edu.au/asd/cedir/index.html). Two members of staff were interviewed from CEDIR.

CEDiR consists of an academic development unit and a learning design unit. The academic development unit is a teaching support service that helps academics develops their careers. The learning design unit includes support of faculty staff implementing eLearning design into their subject. They are connected to the library and learning advisors who work with academic staff as well as with individual students. CEDiR helps academics to be innovative in their teaching and to enhance the quality of teaching, which improved of the student learning experience. As Participant Quentin was aware:

> *It sets up networks across the University between disciplines. It is set up so it provides all the elements that you need to go from probation to confirmation of their appointment at the University.*
>
> *This division has a range of ways of providing staff development at the UOW campus. However, with the satellite campuses, video conferencing facilities are used.*

The unit is engaged in many activities and processes to deliver professional development including the Introduction to Tertiary Teaching course, workshops and seminars, project work, and reward and recognition initiatives.

5.7.5.1 Introduction to Tertiary Teaching (ITT)

Introduction to Tertiary Teaching (ITT), formally called the *University Learning and Teaching* (ULT) is a compulsory course for all academic new staff which is run by

CEDiR. Offered as a graduate certificate, it is a professional development program for university teaching staff designed to enhance their teaching effectiveness and to provide an educational context for ongoing career development (Layton, 2011). This program is for those with experience of teaching who do not have the qualifications required for an exemption from ULT. It involves collegial enquiry into ways in which the evidence from the participant's teaching or educative practice can be translated into a persuasive case for recognition (Layton, 2011).

ULT is a three-part course. The first part is an intensive one week course providing foundation teaching skills where staff from CEDiR and other departments at UOW discuss teaching and engage in specific activities related to quality teaching. This is followed by two observation cycles and a written peer review. Staff must also write about their teaching philosophy. The third part of the program is a major assignment which is to be a draft of an academic article on teaching which can be submitted to a journal or it can be the construction of a teaching program.

The ULT course can be embarked on either a one or two session blended program of study in which two one-day intensive workshops are taken at the beginning of the first session and two half-day workshops are taken at the end of the first and/or second session. There are selected workshops and/or online modules in between these workshops (Layton, 2011). This program offers practical support, develops continuing reflective practice and the development of staff skills. Staff can discover key concepts of teaching and learning, increase their capacity on active and comprehensive teaching strategies, engage in and reflect upon teaching with a peer, and complete a negotiated project about teaching and/or learning in their discipline (Layton, 2011).

Staff employed by the, Graduate School of Medicine (GSM), take the GSM *Faculty Development Program*. This includes modules, some of which are offered by CEDiR. This program requires staff to undertake a sufficient number and depth of modules from a wide array on offer related to their areas of teaching. Modules combine theory and practice, active participation and interactivity, reflection and peer feedback. Role-play and rehearsal techniques are also used (Layton, 2011).

Finally, academic staff may receive credit for equivalent achievements. These are

negotiated at an individual level for those with an extensive background in university learning and no associated qualification, or those who have successfully completed ULT.

5.7.5.2 Workshops and seminars

CEDiR provides workshops and seminars. Workshops involve educating academic staff on how eLearning site can be best used and implemented into a subject and how to improve the use of existing technology to provide better outcomes for student learning. In addition, CEDiR provides leadership workshops in order to promote a teaching and learning concentrated culture within a research-intensive culture (Parrish & Lefoe, 2008). They also provide guidance on how to publish in teaching and learning. The scholarship of teaching and learning comprises staff development to explore innovative ways to teach such as role-play. Much of the work in the unit on innovative teaching and learning revolves around assessment. As Quentin noted:

> *If you are making changes in the way you are teaching then you need to make changes in the way you're assessing and the two need to be linked.*
>
> *If they are actually in an assessable activity that is a much tighter way to design a course than saying 'here is the content; this is how we are going to assess it" through exam or oral presentation or essay. Then you're assessing something that is a different activity from what they learnt.*

These workshops are sufficient for raising awareness and for providing information. They are also important for networking. However, these workshops are less effective for teaching practice. As Quentin noted:

> *Workshops and seminars are only one way and probably the least effective way in changing things...... It is something you have to do but it's not the only solution...... People forget the information. It's not done in their workplace or when they actually need it..... workshops just raise awareness.*

5.7.5.3 Project Work

CEDiR achieves much with 'Project Work', working side by side with academic staff. Projects include changing the curriculum, developing learning materials, and co-teaching with academics in their classroom. They work with staff on projects that are related to their needs. The projects are authentic, experiential and tailored to their individual requirements. In the staff development process, they practice what they preach. They learn, reflect and accept the advice from the expert. It is considered that that even a little exercise is far better than none at all in order to encourage other staff

to exercise and design authentic experiences in staff development activities with assessments. So the process should be experiential, flexible and customized to the individual. As Quentin noted:

> *So we try to practice what we preach. So we're demonstrating what we would like them to do in the classroom.*

The faculties scholars program is an example of project work. As Quentin noted,

> *Every year there were five faculty scholars. They form into a network. Xie supports each of the five to design something different and new for their faculty in terms of teaching and learning.*

This process is in accord with Ramsden and Martin (1996) finding that projects are significant in teaching development and research into teaching as they count in grants for teaching, for publications on teaching and learning equally with other research contributions. UOW has a very good reputation for teaching and learning. As Quentin noted:

> *Our national survey of students' experience we always get 5 stars. We get one of the top ratings for the quality of the learning experience.*

5.7.5.4 Reward and recognition

Focusing on 'reward and recognition' is another strategy that is used in career development at UOW for effectiveness and as motivation to promote good teaching. This is significant for academic staff in order to develop their capacity to innovate and rethink about the quality of teaching connected with research in the disciplines at university. It is well known that when it comes to employment and promotion academic staff at UOW and elsewhere believe that excellence in research is valued more highly than excellence in teaching. To redress the lack of emphasis on teaching, the Australian Learning and Teaching Council (ALTC) was established in 2004 to offer a national focus to enhance learning and teaching in Australian higher education institutions (Chalmers, 2011). This has since been replaced by the Office for Teaching and Learning. The ALTC, and the predecessor Carrick Institute for Learning and Teaching in Higher Education, has offered over $1.3 million in competitive grants and fellowship funding to academics in order to improve learning and teaching in the mathematical sciences (Mallet, Nelson, Porter, Dekkers, Townley-Jones, Hudson, Belward, Coady, and King, 2013). Funding is for competitive grants and projects which include professional development, using technology to enhance teaching and learning, student learning, research and

discipline-based projects (Chalmers, 2007).

Another teaching quality initiative was the Australian Awards for University Teaching to reward excellence in university teaching (Chalmers, 2011). DfES (2003) support rewards and improve standards of teaching in higher education institutions:

> *In the past, rewards in higher education particularly promotion have been linked much more closely to research than to teaching. Indeed, teaching has been seen by some as an extra source of income to support the main business of research, rather than recognised as a valuable and high-status career in its own right. This is a situation that cannot continue. Institutions must properly reward their best teaching staff; and all those who teach must take their task seriously (p51).*

A significant part of what CEDiR does is providing peer review for teaching grants. Quentin described his role as:

> *Helping people apply for the Vice Chancellor's teaching awards and national awards so they are rewarded and recognised. I also do a lot of work on the Promotions Committee so people get promoted for their teaching.*

At UOW, the Vice-Chancellor's Awards for Outstanding Contribution to Teaching and Learning (OCTAL) are awarded each year to general, academic, early career teachers and sessional staff who have made a major contribution to teaching and learning excellence within UOW. These are presented at an awards ceremony to showcase the winning staff and to provide impetus to other staff to think about and to work towards better teaching. The top OCTAL award is $10000 (refer, Table 5.23). These awards are in accord with findings that one of the most important incentives universities can wield to motivate academic staff is pay and reward (Young 2006).

Table 5.23 Awards for OCTAL

Prize money	Award
$10,000	for the Vice-Chancellor's Teaching Award
$2,000	for an Early Career Academic Award
$2,000	for a Sessional Lecturer/Tutor/Demonstrator Award
$2,000	for a Program that Enhances Learning Award;
$2,000	for a General Staff Award for outstanding contribution to Student Learning.

* Data Sources: http://focusonteaching.uow.edu.au/octal/index.html

5.7.5.5 Learning Design Unit

The Learning Design Unit (LDU) is the part of CEDiR that deals with the implementation of technology into teaching, as well as how technology can be best used. They work collaboratively with subject coordinators to design materials in order to improve student outcomes. From the LDU perspective, learning design provides both the lecturer and students with a learning experience that involves three

components: learning resources, learning activities and learning supports (Agostinho, 2006).

Currently UOW uses Learning Management System (LMS), Blackboard Vista version 2. In 2013 the learning designers are focused on the transition to the new UOW learning platform which is freeware (Moodle).

5.7.5.5.1 Support academic staff in the use of eLearning

Learning designers work together with academic staff to support teaching innovation and to improve learning outcomes across the University. In the LDU there is a member of staff who is associated with each faculty, specifically the faculty representative. The faculty representative in the LDU is important because they understand the needs of their faculty and establish a relationship to ensure the smooth delivery of workshops and developing familiarity to work collaboratively. As participant Raymond noted:

> *Within Informatics there is a teaching and learning series where I act as a facilitator coordinator, so I don't have to run them myself. I did a needs analysis of the Faculty to see what topics they wanted, and then I worked out people to run them.*

Learning designers specialise in supporting high-quality design for the use of eLearning. Their specific aim is to work to change academic teaching practice: to change teaching and learning away from traditional modes of delivery, such as lectures only and using the online environment rarely to upload content.

Learning design staff provide consultation, project support, workshops and development of online resources and activities for use in the new learning platform (Moodle). Consultation services include general support for eLearning, a discussion of designs of specific learning activities appropriate to the discipline, finding information on innovation within learning and teaching, and how new applications and technologies relate to academic staff teaching. They can also support staff to engage in strategic teaching development, to help in evaluating projects and in collecting evidence to develop projects to the next stage (Learning Design Unit, 2013).

5.7.5.5.2 Strategies for staff development

The learning designs unit adapts a number of strategies when undertaking staff development at all campuses. One strategy deals with new academic staff without experience in eLearning; another with the roll out of new technology across the institution. New academics may attend a workshop with a LDU staff member to help them achieve their aims. The LDU staff become aware of an academic when a new learning site is requested or the academic staff member may have been referred from their school to learn e-strategy. If the LDU is introducing a new tool then a series of workshops are planned and pre-scripted with lesson plans using resources such as PowerPoint. This shows academic staff examples and guides them through the process.

The other model used for professional development is when a small teaching team has a particular eLearning problem: learning design facilitators come up with solutions. In another instance, it might be a multi-location teaching or blended delivery or where online communication to facilitate group work in their teaching is covered in a broader sense.

Visiting academic speakers giving talks on specific issues related to teaching and learning are another way for professional development. As Raymond noted:

> *Recently a guest lecturer from the States talked on 'mobile learning'. The lecture theatre was ¾ full.*

5.7.5.5.3 The workshop plan

LDU provide workshops which revolve around teaching at the University. The workshop plan focuses on the active engagement of participants in content and in the sharing and construction of ideas. They recognise that staff members are professionals in their own context. As Raymond noted:

> *Bringing staff together, and facilitating their co-discovery and their sharing and construction of their ideas it is much more sustainable.*

The general strategy is to encourage academic staff to think broadly as to how they can value-add with the online components in their teaching. The facilitators in the LDU work with the faculties to develop programs in order to meet their faculty's needs. Facilitator prepares a teaching plan with the aims and objectives of the workshop that enables the audience both to learn and achieve as well as to engage in

the process. At the workshop the facilitator asks academic staff what they hope to achieve from the workshop, so the facilitator can adapt the workshop to their needs.

The facilitator starts the workshop talking in broad terms about the main features of the new tool before breaking it down. For example, they might show academic staff different features such as content management, assignments, content upload and discussions, before covering them in more detail. The workshops are usually delivered in a computer laboratory and using a white board. The facilitator uses a few resources so that the participants in the workshops can practice the activities. As Raymond noted:

> *I will start with what they hope to achieve, then move through some content and usually that results in a lot of discussion being embedded.*

The facilitator uses PowerPoint slides and distributes them to the academics. The information is presented and staff are given time to think through their response. It is an efficient way for staff to think how they would have to respond themselves. This collaborative development involves reflection and may include sharing with a partner. As Raymond explained:

> *If fifty people are in the room, they are asked to work in pairs for ten minutes sharing a couple of things, using the whiteboard and make lists that are generated from the whole class.*

5.7.5.5.4 Challenges

The facilitator in the LDU uses evidence-based literature from the field, keeping current with relevant literature, journals and conference papers. In addition, ideas are shared informally with other universities. Conferences provide a further opportunity to network.

The main issues facing staff developers are a lack of resources and time. Another issue for the LDU is that it does not have a 'strategic professional development plan'. It may be that since this department only has about ten members it is difficult to develop an overall strategy for the institution. Raymond says:

> *I would like to work with the academic developers on a broader strategy, but because they have their own specialisation.......These are important projects that leave little time to sit down and discuss the bigger vision and to look at the bigger picture.*

The LDU is evaluating the next learning management system (Moodle) which UOW is implementing from 2013. This may present an opportunity to have greater

discussions about how the LDU can develop a strategic plan for long term eTeaching and its implementation phase.

Another challenge is the engagement of academic staff in programs and for academic staff to attend workshops. There are two reasons for the low academic turn out, staff have a very busy workload including research publication and teaching is a lower priority.

Academic staff need support as many use a teacher centre model with the use of lectures followed up by tutorials and online resources. As Raymond noted:

> *I look at people's eLearning space and I also have one-to-one experience. I also do support for academics when I see their sites and they seem to have transferred existing face-to-face teaching practices onto online.*

5.7.6 Curriculum Development and Review, Academic Development

The curriculum development and review unit assist strategic change initiatives related to curriculum design, renewal, integration and evaluation. Support for curriculum mapping, design and development advice is provided through contribution to relevant committees and collaboration with faculties to identify curriculum needs. The unit also develops and implements generic and faculty specific workshops and resources. It also facilitates leadership for strategic change within faculties. High level development and support is provided to reward and recognise teaching through teaching-related career development (Academic Development Unit, 2013). One member of staff was interviewed from this unit.

The organisation values academic staff as learners and appreciates change and improvement over time. Academic staff, are encouraged to find ways of sharing with colleagues whether it is through a blog and/or regular meetings.

5.7.6.1 The aim

The broad outcomes for this unit are to gain trust between academics and their peers and between them and the developers in the hope of them becoming learners with the tools and resources to bring about change themselves so improving their learning. As participant Udela observed:

> *My job is to make people more satisfied with how they work and what they gain from their work. If I can make people more effective, by having a resource, having some information, feeling supported and being an agent of change then*

you see real results in how their students are learning.

5.7.6.2 The participant experience

The experience for Udela comes from work, colleagues and a number of websites. The participant learnt by doing and by learning from mistakes, by reading articles from three journals in particular: 'Higher Education Research and Development', 'Journal of University Learning Teaching Practice' and 'Studies in Higher Education'. As Udela noted:

> *I realised that the curriculum bears the burden of explaining to people what it is the teaching should do and whether it actually does it. So I saw the curriculum as a powerful tool to bring about change for people and to help them to do what they wanted to do.*

The developer follows 'distributive leadership'. This does not mean that an individual should wait for change to be driven by those who are leaders with authority but that every individual can be a leader. It also means unlocking that potential for leadership in all academic staff. Udela noted:

> *With anyone you are dealing with you need to build trust. They won't listen to your ideas until they trust you intellectually, and you render information accurately and are trustworthy with their frailties'.*

The developer perspective is to treat the other person as a learner, they are not a fully-fledged expert in everything; they are learners. Even though staff have some expertise in their area, they can learn from and share with other staff so gaining experience to bring change. As Udela commented:

> *Share the journey. Other people can learn from the hurdles that you faced, seeing that you weren't successful at every turn. But success must be shared, so other people can look and say "she can do that, so can I". That is what sharing can do, "This is the pathway. Let me help you down that pathway".*

Another important developer perspective is keeping track of the process. Achievements and outcomes are written up as a report/newsletter to allow academic staff to share ideas, to understand the work, to see the evidence of outcomes and the ability to meet the job description. This will bring changes to academic staff in their job. As Udela declared:

> *Academics at the University in particular, are more likely to change their practice if they have a colleague who is doing something and indicating that it is effective, useful and fun.*

Udela became a subject co-ordinator and then a course co-ordinator as well as

working on collaborative projects within the learning development unit, the learning design unit and the Library. The collaborative project focuses on helping students to develop the skills they need to become a good scholar such as information, statistical and computer literacy and how to write.

In academic development helping both individual academics as well as faculties is important to bring about a change that improves teaching and learning for students. As Udela noted:

> *Appreciate other people's world views. That's the first step. "What is it about other people that they know? How do they think they come to know it? How confident and certain are they about their beliefs and understanding about the world or the University? How amenable are their views to being altered? What changes would they like to make? And how can I help to make those changes?" People really want to improve and do a good job*

The developer worked with Mathematics and Statistics staff, who have a culture of sharing ideas and techniques. The staff seem very motivated to help students understand and already know that 'chalk and talk' is not enough. As Udela stated:

> *They have been part of developing an online tool for 'statistical literacy' and I have reviewed that tool and tried to get it implemented across the University.*
>
> *What I admire about the Mathematics teachers is they used this technique where the whole room is full of chalk/whiteboards. So when students are working on the board, the other students can see the work and the teacher in the room can see and help without having to go and lean over the student's shoulder. The student can explain their decisions along the way, this leads to overt rather than secret decision making. And they would have to explain how they solved the problem to other students. It is in the explanation that it is shown if the student really understands.*

For development Udela says that trust is very important. To obtain that trust the developer needs to connect with the values and beliefs of the individuals that the developer is helping. Udela stated:

> *Changing values and beliefs is much harder than changing practices. Developers have to change the practices first then the values can change*

5.7.6.3 Workshops

The Curriculum Development and Review unit delivers some workshops with staff who are interested in change and want to find out more. From the participant's perspective, a committee is good practice for teaching and to bring about change; although some academic staff find committees are a waste of time. The best

committees and workshop groups have clear terms of reference and a specific job to carry out. Ideally, someone on the committee should have good access to the senior executive so that the voice of the committee can be heard. The committee should be resourced and funded to carry out the project. As Udela observed:

> *I also use those committees to share information about what I want to do and to share my perspective....give a little point-of-view with evidence and outline what the research says on this matter but showing how it will guide us*

Another way for professional development is to have academic staff invited to faculties. This can be the form of an informal teaching/learning group, a formal education meeting or it can be a special group to hear or discuss matter. Academic staff can also be invited to an individual meeting if there is a particular matter to discuss, such as curriculum, mapping of graduate qualities or assessment. Individual meetings are a significant method because academic staff are more relaxed and less defensive and the support and advice provided to them can be modulated. As Udela declared:

> *Staff usually are more honest and authentic and they usually want some advice or help. They feel more likely to ask for that in that setting.*

This unit has a website with a blog called UOW curriculum which focuses on teaching. As Udela indicated:

> *The best about being an academic developer is to get to do 'academic detailing' where you go and listen to that individual academic, help frame what the problem is, discuss a plan and a solution then get together and evaluate how that is going.*

An example is of accessing information, the ability to find information by being able to carry out good quality searches of the Library and electronic databases. Even though UOW has an electronic data base, many students do not know how knowledge is generated to create a discipline of knowledge and they did not know search tools. It is important to develop a search strategy into a logical program and then carry out the research. As Udela maintained:

> *These skills cannot be taught overnight. So I worked together with my colleague in learning and in design and development and in the Library to introduce students to these different skills in the four first year subjects. Each subject shared one task of helping students to learn those skills by a lecture, a work sheet, a workshop and assess those skills in different sorts of assignments and online tests.*

Moreover, developing resources, newsletters, service on committees, chairing

projects, carrying out research and meeting individual deans, finding out the Faculty needs are very important. One of the senior librarians suggested that when lecturers structure the first assignment they could set students up to experience success in researching a topic as Udela noted:

> *We would design a research topic and then talk to the librarian and do a search together and make sure the students will be able to easily find good quality current information. Let's limit the assignment topic so they don't have to read every article written. Let's narrow it down. This enhanced student learning.*

This is learning by doing or by accessing independently run workshops at the Library and in learning development. As Udela explained:

> *One of my colleagues in the Library, followed up that first group of students who we evaluated carefully. She met them again three years later in their final year and she had a focus group. She wanted to know if the results of the activity they undertook in first year persist. We now know how essential those skills are. Also they said, even though after they did their first year subjects they found themselves helping second year students. As they were in the Library the second year students would say, "How did you learn how to do that?" That gave them more confidence and they realised, in fact they were very able, they had nothing to compare themselves to.*

The developer also delivers a workshop on assessing learning and learning outcomes that facilitates teaching practice. The developer acts as a peer reviewer of teaching. Udela explained:

> *If people want their teaching reviewed I will go and sit in on their class and review their class and write a report.*

The developer delivers a two-hour workshop "The Subject Proposal Form (SPF)". In this workshop the developer gives staff pretend and real forms to critic, then asks staff to write their own SPF. There is a handout that explains the concept and offers ongoing help and assistance.

This workshop was introduced to help academic staff write a good quality curriculum. The Subject Proposal Form (SPF) is a very important document. A subject proposal form has to go to the School for approval, then to the Faculty's education committee for approval prior to being signed off by the Dean, then to the Course Approval Management Group before finally being confirmed by University Council. Eventually the SPF is reported to the Government Department that both funds the University and keeps an eye on university quality. In addition the Subject Proposal form contains information about the number of credit points, which session

it is offered, how it is assessed, which text books are required and what the learning outcomes are. In effect, it is a contract with students. UOW makes this information publicly available. When students are considering studying at UOW, they can examine this information as a part of their decision making as to whether the subject is going to meet their needs.

A workshop provides staff with an opportunity to practise in a safe environment and to share ideas with colleagues. Furthermore, the workshop facilitates awareness, provides information, and offers staff an opportunity to use a technique, or to refine a comment on an existing technique. A workshop can also provide information in advance in written format or via a web page which can be built upon the workshop.

5.7.6.4 Bring about change

The unit provides many different ways of developing staff such as individual consultation by phone, face-to-face, email and by inviting eminent including international speakers to give presentations and to deliver workshops on key issues such as assessment. The participant considers that workshops and seminars act to advertise what the unit has to offer, but that the academic who wants to change will want to meet individually or with a small group or they will want to host a workshop. As Udela noted:

> *Academics are odd. One will like to go to workshops, another will only want a handout, they haven't got time for a two hour workshop, or can you give me a website? Or others want to come and do a five day course in university teaching and learning and then they might go and do a formal course to get a diploma or a degree. Other academics want to write for a journal or read journal articles. There isn't a one size fits all.*

The best way for UOW to bring about change is by 'policy' and guidelines. However, staff rarely welcomed being required to change through policy or procedural changes. Udela explained:

> *Policy is more likely to be implemented effectively. And policy is a good way to bring about change. That's why I am on committees, because they help draft policy.*

Mostly academics follow policy set by the University, although there may be School specific policy. Udela noted:

> *The culture of UOW is a good culture: it's positive, it's interested in change and there is formal recognition of those who carry out innovation, bring about change, embrace technology, and achieve a great job.*

5.7.6.5 Challenges

A challenge facing staff developers in this unit is time. As Udela indicated:

> *Some of things I'm supposed to achieve in eighteen months will take five years to achieve....to work out what the problem areas are and start implementing some strategies and get an evaluation and get a sense of what is working or not working. It takes a while to work out the culture and the processes of a particular place.*

Workload is also an issue. Most academic staff have a large workload and are working to full capacity and very hard. The University tries to ensure that staff have similar responses to similar problems, to follow policy closely, not to do anything that will bring the University into disrepute and, in fact, to do things that bring it into good repute. This is a challenge because academics are notoriously independent and do not necessarily feel that their first allegiance is to the University, rather they may feel allegiance is to their faculty, their discipline or even to their students.

Another challenge is that the University consists of many groups. The University, in trying to manage risk and resources, would like to have the same system and rules apply equally to everybody. But it must also recognise the individuality of the sectors that they are trying to manage and allow individuals to function with a degree of independence and autonomy.

The review and improvement curriculum presents many challenges. It requires that the developers be multi-skilled and interact with different faculties in different ways. It is important to find other ways to draw people together to share ideas and practice and adapt the best practice from each faculty into their own faculty. To keep staff open to change Udela noted:

> *It is to keep people on that journey of "okay, to improve this, how can we do better?" If we want people to change, it is even better if they identify the need to change, and they have the initiative. I say "Wonderful, then I come on this journey with you".*

Academic staff turnover is greater in some areas than others. There is also the issue of the implementation of a new policy or practice. For example, following policy changes, academics have to now use eLearning. The techniques for creating eLearning space to include questionnaires, discussions, links to sites, academic and

learner developers and library staff and learning design will collaborate to help staff to enhance student learning.

The level of alignment of new technology with the beliefs and the feelings of staff members is a challenge if resistance is to be minimised. If staff have a firm belief that new technology is time consuming, not helpful and frightening then they will feel pressured and compelled to use the new technology. Resistance will prevail.

Recognising and rewarding staff are two ways to drive change. Rewards are a key part of promotion and probation criteria, so that the staff who are natural enthusiasts have a chance to put rewards onto their CV.

Other issue is sustainability for the developer which is enabling each person to exert leadership, not to be a leader but to be free to express leadership by identifying areas for improvement. This involves the capacity to improve these areas through initiatives which might include bringing colleagues along for the journey or by engaging senior staff at the University and obtaining resources to bring about change. Networks such as discipline, professional organisations and the committee structure at UOW can be used to drive change.

5.7.7 University of Wollongong Library

5.7.7.1 The professional development for the librarians

Six members of the library staff were interviewed. Librarians are highly qualified, with a librarianship degree who undertake regular practical training and work experience. Participant Jane who works as liaison services librarian noted:

> *The Library always has had very good training.*

This is supported by participant Lyn, who works as a research training librarian, who commented:

> *When I first moved into the librarian position I sat with the individual librarians and learnt about their area.*

A librarian can attend university workshops where expertise and knowledge is available. When staff join the organisation they have a structured induction program and activities are introduced within the first twelve weeks of their employment.

The professional development programs which are provided by the University

Library cover the broad range of areas and skills that are required by librarians for delivering services to students, researchers, teachers and academics. These areas include client service skills for dealing with both public and internal inquiries; service awareness; information technology service delivery; research; service delivery; information service delivery; access delivery service; research online capable deliveries; leadership and coaching. Training also includes learning about new databases as they become available.

Librarians can request to undertake suitable training when it is available. If training is offered internally or externally, it is advertised by the Library. The advertising offered depends on staff needs, relevance and cost involved. One strategy is to train one staff member in a new technology who then trains others. Participant Maureen who works at development technology services and administration in the library, commented:

> *Staff would go to something they may have identified with where they may need extra level of skill or are interested in it for a development opportunity to progress to another position to further their career.*

Staff in the Library are encouraged to attend external conferences, which can be library based. UOW also supports librarians financially on an annual or bi-annual basis to attend relevant forums or workshops. When staff attend an external forum they are expected to report back at a staff meetings or on a blog; there is an expectation that they will share what they have learnt with others as well as any associated recommendations or actions.

Overall the Library staff have a strong engagement through discussion; reflection and negotiation of the goals that librarian want to focus on in 2011 and beyond. Because the Library focus is on building a culture of sharing knowledge and the notion of storytelling, what librarians learn along the way is very powerful. Participant Paul declared:

> *I think the level of engagement is quiet strong. We do have some evidence as well through the University's Climate Survey, our own surveys that we conduct within the organisation, focus groups and other forums where we have a culture of people being open and sharing – what they like and don't like, where they think we can improve. So the data show us that they are very engaged.*

The Library tries to build opportunities where teams or individuals share their development journey, for them to reflect and share what they have learnt about

themselves and their peers and what information they can give so that they may continuously manage better learning in the future. The Library seeks to illustrate that the individuals in the teams within the organisation have the capacity to continue to grow. Paul said:

> *I will go to some of the people and will say, are you doing exactly the same thing as you were doing five years ago, they will say "no". So they have had to develop new skills to be able to do their job now. So we have to make sure we provide them with the right opportunities to develop those skills.*

Keeping the librarian up-to-date with skills and knowledge has a financial aspect but as Paul indicated:

> *It's a limited cost thing as it is staff time away from their work. We are not bringing in an external facilitator, or we don't have to pay for travel costs. An initiative that we are working on this year is an internal coaching network.*

The relevant professional association, the Australian Library Information Association (ALIA) has a strong impact on professional development. The ALIA provides annual conferences that are tailored towards library work. The Library encourages librarians to attend ALIA conferences and forums to understand what is happening in the profession and what is new to keep them up-to-date. The UOW Library uses the Australian Business Framework. Paul noted:

> *It is a good holistic framework that we have used for years. It has a people component in it. It has a number of good practice principles within it that we monitor and review ourselves against.*

There are also other groups, such as CAVAL (http://www.caval.edu.au/) which is an Australian company established to provide library services to university libraries, public libraries, special and government libraries in Australia, New Zealand and Asia. CAVAL offers leadership programs and developing programs. Other external providers offer specific courses tailored to the career development aspirations of the library staff. Librarians can visit the library web site and the librarian can deliver training over the Internet. As Maureen noted:

> *The Library staff were giving a demonstration in how to use the catalogue and how to help their students at their end. So it was training delivered.*

In addition there is an annual performance planner process, which is an opportunity for team members to negotiate their career development goals including personal and professional development activities with their leader/manager. This allows the organisation to keep a record of development needs, which can then be used to

develop strategies to help close any knowledge, skills or experience gaps. Staff can also identify goals that they want to achieve to support the organisation or strategies. A range of learning and development activities were examined, although staff need to align their goals to the organisational needs. As Paul indicated:

> *It may be on the job training, or secondment within the organisation or attending training programs external to the Library.*

5.7.7.2 Librarians and technology

The librarians demonstrate understanding of technologies, the importance of sharing knowledge, what technologies are needed and how they will fulfil the needs of the future. Furthermore, the staff have presented papers and created a journal on their home-grown competency based program called the *Journal of Organisational Transformation and Social Change*. There is a planned approach to supporting the training needs and expectations of the staff. Maureen explained:

> *The undertaking of the staff development is that we make sure the person is supported. We don't leave it for someone to do the training on their own and there is a group or a buddy they do it with. It is a shared learning experience. They are not on their own.*

In 2011 changes taking place in technology were identified and core-training programs were developed which included using typical software such as Microsoft office/suite and file management. The Library added to this an awareness of web 2.0, social media and different web interfaces. Although many students and academic staff were engaging in these technology spaces, they found that not all academic staff were familiar with the technologies. The librarians have an understanding of 'elements of total quality management', how to understand processes and how to build process improvements. Paul noted:

> *It is far ranging. For example this year the liaison services team is working closely with academic developers to further develop their understanding of pedagogy in the 21st century so that they can adapt their learning and teaching skills accordingly. We are also putting a lot of effort into leadership development, trying to grow leaders from within the organisation as a succession management strategy*

Staff have a responsibility for technology development. For example, in the liaison services area they have seen how they can use different technology platforms to package and deliver library services. They examine how to create different types of learning activities and objects in an online environment. Librarians are responsible for keeping abreast of all new changes with technology; some librarians are trained

in Web2 technology within education.

As a consequence of changes occurring in student engagement, attention and research in 2011 the university began a workforce plan that would respond to these changes. For example, changes in IT use within libraries have been quickly progressing. It is about identifying where the real need is. Maureen observed:

> *There is so much happening. You could spend money training people and then within twelve months that technology isn't used any more. Or you could buy that technology and train the staff up and we are not going to use it because something better comes out.*

They received positive responses from training. As Maureen said:

> *We currently have seven or eight of those surveys back and they have all ranked the effectiveness of the training in the excess of 95% satisfaction. We asked them*
> *How well did this training program prepare you for your job?*
> *Do you feel preparedness for your job?*
> *Do you use the training program resources after in your job?*
> *90% of them found it very effective; they felt ready for the job they started.*

5.7.7.3 The use of technology

UOW embraces different types of technologies and is moving into other technologies. There are a number of sub-teams or committees within the Library. One of the committees is a technology reference group whose role is to stay abreast of development in technology. This includes existing technologies needs within the systems, developments with Web2, and mobile devices and how the organisation should respond to these developments.

In 2011 the Library worked on a web interface for mobile devices. The Library is trying to keep up-to-date by sending people to appropriate conferences and forums. The Library also uses the technology of the StartSmart which is a compulsory academic information skills course for all new UOW undergraduate students. StartSmart assists students in learning to recognise and use academic resources. Staff worked with learning designers and other units to develop online learning and assessment programs.

To keep abreast of changes there are many opportunities for professional development, although they are time consuming. As librarians work with many

students and staff, it is difficult to know what to recommend as best resources for each of them. Paul noted:

iPhone 4, iPad 2, web 3.0, the Cloud, there is so much change. What might have taken five years now only takes one or two years.

Librarians do not focus on one particular technology but develop a degree of understanding on a variety. They must be comfortable with the knowledge that the job will change on an ongoing basis. Paul explained:

Our goals will remain the same but how we get to the goal may change considerably. So we regularly do review the structure of the organisation based on our knowledge of what our clients need and expect. What technology is out there and all the other drivers, such as Government/society/economic drivers. We look at the knowledge and skills we need to keep us viable, relevant and competitive.

Keeping up-to-date with technology is very important because the Library needs to have that dialogue with clients. It has to deal with change and needs to be flexible. There needs to be constant up skilling. It takes energy and commitment to persuade librarians to tell their story of what they have learnt and achieved. As Paul said:

…because for other people it is important to hear from their peers. That they have the wonderful capacity to change, to continuously learn new skills and develop.

An ever present challenge is to have librarians trained quickly with the use of ever changing technology. Another challenge is dealing with the timeframe of getting librarians up-skilled to use that technology. As Maureen noted:

It is the responsibility of someone to maintain the modules and keep them updated. They are evolving all the time. Things need to be added to them, things change to keep the modules really current.

Librarians at UOW use current technology to teleconference such as Skype or WebX. This is where technology can be used to share documents and other resources with each other to facilitate a developmental activity.

Developing countries are very keen to learn about the way western society and western universities have applied professional development. For example, some of the librarians have had experience in countries such as Singapore and Malaysia. A recent example is the work UOW is carrying out developing new partnerships at Subang Jaya, Penang and Sarawak in Malaysia. For the first time UOW librarians

have been using WebX technology to facilitate discussion and training. They have trained the librarians and faculty staff in Malaysia to make them aware of the resources available. As Jane indicated:

> *I have worked with the library staff to teach them about our resources because students can use their own and our Library to access information from their own country......They were very keen to learn about the way UOW did things, to share and for their students to use resources and UOW resources.*

This is beneficial for Malaysian students able to access the best resources from both worlds. Therefore, the exchange and sharing of information is a valuable approach to learning.

The feedback from staff in Malaysia allowed UOW staff to see what has been useful, what is working or not working and where Malaysian staff can develop their systems delivery platforms better than that offered by UOW. For example, in Malaysia students or staff cannot access online library resources outside the library. As Paul explained:

> *So they don't have authentication proxy systems. So that is a learning and development opportunity for them and is something they will take back to their institution to see what they can do to enable them to access outside their institution.*

5.7.7.4 The aim of professional development

The main component for librarians' career development plan is to maintain professional development. The aim of professional development is to develop a high performance culture within the organisation. Staff need to be both skilled and knowledgeable, but also to know what the Library expects from them in the workplace. This is one reason why the Library has core training and competency based programs, to ensure that librarians perform their job to the best of their ability and consequently achieve a high client satisfaction. To achieve these aims they consider what resources they provide within the library. For instance, they have a position called 'manager workforce development and planning'. This librarian's role is to work within the Library with the executive team, the team leaders and managers to identify what skills gaps exist. If the Library has already provided relevant training but the outcomes sought are not being achieved then this raises questions of whether the training program needs to be changed.

Organisational development examines how to create a high performing organisation

by developing staff. Paul noted:

> *Using those principles and guidelines, relevant staff identify the training programs and the professional development activities our staff need to gain competency in so they do their jobs well now plus those programs and activities we need to do to prepare them to do their jobs well in the future.*

Maureen who works at development, technology services and administration in the Library commented:

> *We also have our own learning needs, our development opportunities and career aspirations and the question 'where do I see myself in two years?'.*

Part of the Library's objective is to not only to support identified needs but also to have a workforce with the skill base and competency to fit the organisational needs. As Maureen noted:

> *So that's what we are trying to achieve: that we have a good professional match to the current and future needs of the industry and that our organisation is responding to its business activities and planning.*

The Library expectations what they want staff to achieve as individuals and also what they want to achieve as an organisation are very clear. As Paul noted:

> *There has also got to be "what's in it for me", but that's where the individuals need to exercise their responsibility in identifying, what are learning and growth needs and how might we work in partnership to fulfil those needs.*

5.7.7.5 The professional development approach and strategies

The Library has developed a structured approach to training based for librarians to achieve the desired learning outcomes. In 2011 the Library introduced modular training for staff who need to know about certain areas. Staff read information, perform activities and are then assessed. Expressed training needs are checked in the annual performance plan. If the goals are still relevant then what progress has been made or if obstacles exist, what needs to be prepared is determined.

Core training which cannot be provided by the Library is outsourced. This is an opportunity for a staff member, in consultation with their team leader or manager, to identify professional development needs. For example, the team leader sets peer and self-assessment tasks and follows up with staff members to assess how well they demonstrate their skills and competency in their daily activities. Internal self-assessment ensures that staff are familiar with specific aspects as well as gaining an understanding of some of the gaps. They refer to the position description, the

Library’s business plan, and a range of competencies that have identified that are common to staff. The librarian can draw upon those competencies and the librarians use this discussion to identify both what the staff member does well and where they need to develop further. As Paul explained:

> *If you are a team leader then there is a higher level of competencies that we encourage people to aspire to and when you get to the executive level there is another higher level set of leadership competencies.*

Regular client surveys are conducted to see how well client needs are being met. This is useful to identify where the ‘gaps’ are and how to close those gaps to make the librarians more competitive with international standard. At the end of each year the Library examines what was achieved and quantifies what evidence there is to show that progress has been made against the goals set earlier in the year. Both quantitative and qualitative data is provided to demonstrate the goals that were achieved.

The Library has seven professional cadet programs. The cadet program commenced in 2005 (http://www.library.uow.edu.au/about/UOW050179.html) and is designed to develop up-to-date skills in keeping with modern changes, especially in IT. The cadets move between teams, with the aim to skill them so that eventually they can enter any unit in the Library such as IT or client services. They gain their skill base by completing modules and working hands-on for an assigned number of months in each team. They develop professionalism skills that can be employed in virtually any team within the library. Regardless of age, staff who are trained in the cadet programs bring different experiences, and have the ability to advance and understand technologies faster. The training program equips librarians so that after three years they may apply for a permanent position.

The Library asks staff to identify what skills or knowledge that they require to do the job or for their career aspirations. This evidence is reviewed and used to inform internal developmental opportunities. Maureen explained:

> *Prior to going on this module we wouldn’t be able to say, ‘yes tick off that that person has covered or demonstrated that competence’.*
>
> *After assessing them four to six weeks after their training on the competency based training program we tick them off,*
>
> *“You may need to be retrained in an area if you didn’t reach the expected*

competency". So we retrain them then we are able to say with great surety that all these people have demonstrated the competency required to deliver these ranges of services.

Competency based training is very rigorous and obtains good results. As Maureen noted:

We have further evidence in our surveys of our clients against other universities, we rank very, very highly, and it has increased since we introduced the program. It has gone up a whole percentile.

This gives the trained librarian the opportunity, once they have completed a module, to provide feedback. Such feedback is provided to the department, allowing the module to be updated. However, it is difficult for the librarians to know how to cover everything but they are slowly building additional modules. The technology services and administration in the Library provide core training to Library staff across a range of activities, using workshops and module based training programs in addition to information sharing sessions.

There are also team specific training programs. They have developed module based competency based training program. The core-training program is developed and delivered annually; however, staff undertake it every two years. The competency based training programs in each team are delivered on a needs basis, for example when there is a new staff member. The modules are developed along the similar lines depending upon which team is included, and which senior staff are needed to develop junior staff. Newly employed staff need to be competent in basic skills and IT core competencies are compulsory for staff to complete. This provides rich data about what individual librarians know or do not know and what their planned performance training and development needs are.

There is much professional research undertaken to investigate what is happening in the environment, who is doing what, how are they doing it, if they are doing it better than before, and how they can learn and adapt improved practice into the organisation.. For example, the development, technology services and administration in the Library identified need through feedback from staff on training, especially where they needed further skills training. This strategy for staff development is used at all campuses. A new service called 'bonus plus' was introduced, where librarians

completed a competency-based module before training Library staff prior to the launch of the new service. Benchmarking is undertaken from time to time to measure how close they are to best practices

The University provides recognition events which focus on the contribution of librarians. Two awards focused on how a professional development strategy has been used to achieve both individual outcomes and organisational benefit. As Paul noted:

> *We can tell you to go to six training courses, but it might not have the desired outcome. We get value if people also identify what they see as their growth area. So you have to have a strong commitment to that.*

The Library uses the word 'competency based' for training purposes, but not for employment purposes. Competency assessment is only used to encourage greater training knowledge and skill attainment.

5.7.7.6 Librarians training academic staff and students

Some librarians co-teach a research class for maths students undertaking Honours or Masters by course work. They also endeavour to cooperate with lecturers when these students have assignments. That is an effective way to improve student learning outcomes. As Jane indicated:

> *Students respond better if we are teaching them something that is directed, such if they are researching a subject for an assignment, they learn how to do it quickly and efficiently. They are willing to come to a class and learn to do it making it easier and saving them time, and maybe allow them to get better marks.*

Librarians contact new academic staff and spend sixty to ninety minutes introducing them to resources for their research area. Many staff do not know many of the resources available in their research area. As Jane indicated:

> *I am finding a lot of new and old staff do not know of the resources available for their teaching or researching. They are very surprised to find out services we can provide. Some of them have been here so long they don't come out of their office to ask.*

Therefore, the Library provides support training for academic staff as Lyn noted:

> *I am part of PODs training, that's the Professional Organisational Development here on campus and their unique job is to train the academic staff. ..... I am part of their training that they offer to academic staff.*

Librarians deliver a lunch time course for academics which is repeated each year. It is difficult to persuade staff to attend, but once they are there it is not hard to engage

them. Jane noted:

> *Many of them say 'thank you' I have learnt something today. When the lecturers bring students along and they sit in the class, they say to me thank you 'I have learnt a lot today'.*

For example where thirty Informatics faculty staff attended a workshop, many comments were made that it had supported their teaching. Jane noted:

> *That it was so useful, good information that they hadn't heard before.*

Due to academic staff turnover workshops need to be offered on a regularly basis. Jane noted:

> *A suggestion to the Sub-Dean was that it should be compulsory for staff to attend. There is a real need to work with their staff and the staff need to attend.*

Academic staff can ask for help at anytime by sending an email request.

The Library takes many approaches for training academic staff because of the difficulty academic staff have in finding time to attend. The Library delivered a program called 'Academic Outreach' where every liaison librarian offered and had an appointment with every permanent staff member on campus to provide information about how to measure research. The librarian contacted staff about the academic outreach program to arrange with them for a suitable time. As Lyn said:

> *We reached 50-60% of staff, visited them for one hour. To give them an idea about our new access tool,...Then from that we might have had some spinoffs where we might give specific seminars to groups of academics and their Higher Degree Research (HDR) students because they are often of that academic culture.*

Librarians also ask academics what they need to know from the Library and what support they would like from the Library. staff ask for help in understanding publishing, Endnote, iPads and iPhones and popular request are searching databases. The Library also provides online support either via PowerPoints or videos, which staff can click on it to see how to do the steps by themselves. As Lyn said:

> *The main components would be identifying the need and what Academic Outreach is about. That program is identifying a need by going out there and having communication strategy with academic staff and back here in the Library, recording that need and then tailoring services around that need.*

Identifying what staff need as well as identifying the gap in their knowledge is important for librarians in order to deliver training, as Lyn noted:

> *The idea about our training is to give people an overview maybe 30-40 mins*

with questions or how we can help them as a group, and then what we say to academic staff – we are happy to meet with you individually, and to talk about your individual needs and to assist you.

As Lyn noted further:

For example, last year I had one academic who said they did not need to see me, however, he was part of the group that I presented to. So I used his publication as an example of the kinds of areas he should be looking at and then he immediately realised – he did have a big gap in his knowledge. He then wanted to make an appointment with me.

The best strategy to show the basics is one-to-one. As Lyn noted,

When you do give the librarian the opportunity at an individual level that usually works out best because then you are getting a complete picture.

The trainer needs to pass on a good understanding of the basics, the next step up and finally the advanced level to developing staff. Even if they are advanced this would give them the ability to understand the information. Having handouts to support staff with that technology is very important. As Lyn experienced:

When I first started teaching Endnote, Endnote was about six hours long. I now book them into two one hour sessions…. My predecessor, what they wanted to do was to tell everybody everything about Endnote that you could possibly do. The problem with that is they walked out very confused. My approach to teaching, particularly when it has a level of complexity to it (and people are new to it) is to only teach some absolute basics, enough to get them in, play and working well enough that they can leave it. What I always say to people that I teach with is give them enough to make them feel confident that they want to explore themselves.

It is important to know what the needs of people are, what they care about and what their capabilities are. As Lyn indicated:

To make a program sustainable the need has to continue to be there, because once you've filled that need – you don't need to continue with that training program only as updates.

5.7.7.7 Information and Communication Technology (ICT)

The co-ordinator for information technology at UOW for all staff and students was interviewed. The participant, who began working at UOW as a personal assistant was one of the first staff members to learn how to use a Microsoft Word processor and passed those skills onto other staff at UOW. This developed into an interest in the use of personal computers following which she was sent on training courses with the

expectation that they would pass that information to others.

The feedback from the Information Technology Services (ITS) support desk where the information from various groups and committees about what the people are having trouble with is significant in increasing the knowledge. As Wendy noted:

> *My support desk will feed me information such as "gee we're having a lot of enquiries about this". Especially when old computers are replaced with new ones, the tech people in the field find out what problems people are having, e.g. "I was over in Education and they couldn't understand ……..". So I get in touch with Education and get something going.*

The participant delivers training sessions for all university staff along with some training for postgraduate students. They introduced the 'rovers' who give individual help. The training is for computing, and computer applications that UOW supports. For example, the program includes Microsoft Office, email, calendaring for Postgraduates and all staff. However for specialised training such as required by informatics, language or nursing, those departments organize it by themselves. As Wendy noted:

> *The reason is why we cannot support other software is we don't have the expertise.*

The aim is to provide a training service to university staff so that they can learn how to use a computer and applications to make them more efficient in their work office. This involves updating skills, for example the use of Office 2010 on the PC and 2011 on the Mac and adding Windows 7 and websites setup and online training and courses and user guides.

Different strategies are used for staff training. For example, one-to-one training is provided for both the senior executive and for staff if required due to time constraints. Another face-to-face technique is a hands-on 'show and tell'. Courses are delivered which have ten people in the class. As Wendy commented:

> *Normally where a course will take about 6-8 weeks to complete say on Excel at TAFE, we cram it into 6 hrs. We give alternatives.*

Following a 'face-to-face', staff are able to take information away to read, and to work through. If they need support they are encouraged to obtain it from the support team. Staff can also look online on a website with a number of links. In addition Microsoft provides a number of free online training modules.

Academic staff can also follow up their training with a short video that the participant produced from Adobe Captivate. UOW has to ensure that videos have a certain professional standard. Even the way they look has to be consistent. It has to have a certain template attached to it and fit a certain size to go on the UOW webpage. Groups of staff from around the university who attend the course were surveyed. Their response was very positive, as Wendy said:

> *Staff liked it- but they didn't want it to replace 'face-to-face' teaching. We have a number of short videos.*

For the participant, face-to-face development is more effective as a strategy than online professional development. As Wendy noted:

> *As the trainer is 'right there' it gives all class participants the opportunity to ask for advice they are doing it like "I've got this problem, how do I fix it?". I can tell them straight away, but if they are doing it online they say "who do I ask?". I will not take their calls for help; I forward them on to our tech staff.*

The support for staff could be through the email or through technical staff, as participant Wendy indicated:

> *I suggest to them in class to send me an email. If I can answer it quickly I will, but if it is more complicated it will go to Tech support.*

In the area ICT one issue facing a staff developer is the age of the staff being trained. Younger staff already know how to use a computer but older staff may be resistant to change. As Wendy said:

> *They are gamer than me, like, I would say "should I press this?", while a younger person just goes ahead and presses it. It is different for a 20 year old, they think how is she going to teach me anything about the computer.*

Time is another issue as ICT is a large task and there is a constant need to update. As Wendy said:

> *For instance I will get an email and they will say, could I make an appointment with you for half an hour and you tell all you know about computing. This is impossible. I have years of experience. They say "just teach me the things I need to know".*

Resourcing and funding the team of training staff are major challenges for the staff developer. Trying to obtain outside services to produce some of these online videos would be a solution. As Wendy noted:

> *I need a team but there isn't any money for that*

> *I don't have money to pay for people. It is just me and I am so busy running computer training for the UOW. How many staff do we have? And over the last*

> *year, my role has moved into other parts, because we bought in a new exchange system so I have become the expert on mail, mailing lists and shared mail boxes.*

The university would like to keep their staff skills is as high as possible. Staff are engaging in programs and most of them want to know how to use those programs to increase their skills. The departments receive funding for training.

5.7.7.8 Faculty of Education

One staff member of the Faculty of Education was interviewed with respect to professional development. The Faculty induction of new and casual staff introduces them to the policies and procedure associated into their roles and the responsibilities of others within the Faculty.

The Faculty of Education professional development is targeted towards the needs of the individual to integrate technology into education. For some staff that might be video conferencing, for others an interactive whiteboard or the eLearning system. As participant Ian who is working in the Faculty of Education in ICT for the Faculty, stated:

> *This year I've talked to all staff about what it is they want to learn…. Then what we look at is how people can be grouped together according to what they would like to learn, so we can run small session, hands-on sessions and sometimes we do individual sessions.*

Time is an important issue. Both for staff to attend and to ensure the timing for the training or professional development is when they can use the skills they have learnt, because they forget them. Training needs to be in context. Ian noted:

> *For example last year we ran sessions for the staff graduate of education students, who needed to implement new ways of teaching and we ran those in the week prior to session. So they would be using them immediately.*

Ian noted:

> *Some staff like to have some readings before they come so they have some idea of what is it about before they attend. As time is so limited there is much information given prior to the class. That is the best and quickest way to do it.*

Another problem is the skill difference between staff. As Ian said:

> *Some people with very basic knowledge need a lot of time and there are other people who are quite advanced.*

He continued on the needs of diverse groups with such different skills:

With the people who only want to do the basics, we make sure they know how to do them and do them well. If something new comes along it gets offered to them and if they are interested they can take it....Then there are other people who are very interested and want to know all kinds of things. It is just about knowing and understanding the diversity of the group.

Therefore understanding the context and understanding what their needs are, how it will work, if it is going to make something better or not encourages staff to adapt the technology that suits their practice. As Ian said:

It's just not about learning skills, it's about learning something in the context of their skills in them doing something….So you would find out who's interested, what they wanted to do and then you would ask them to come up with ideas of how they could use it in their teaching.

If they are a good teacher and they are improving their teaching then they will find a way to fit in the technology.

Keeping up with new technology is a challenge in particular for older staff. Even though the university uses eLearning, the Faculty of Education uses a program called 'Janison' which is similar to eLearning.

5.7.7.9 Faculty of Commerce

One staff member from the Faculty of Commerce was interviewed. This person works as a teaching and learning consultant to help other lecturers. Most of the experience of this participant, Yung, comes from work experience, attendance at in-house professional development workshops, conferences and reading relevant literature. As participant Yung noted:

So in order to support them I write the handouts which are sort of supportive documents and give those to them.... come into their office or make an appointment..... So over a period of time people change

The aim of this professional development strategy is to develop sustainability, to build capacity in a lecturer to have the confidence to work with other members of staff.

The workshops are scheduled over a lunch time period for an hour and half to accommodate groups based around staff availability. Sometimes Yung offers individual consultations seminars or lectures. The reason for this is that training needs to be flexible, to be able to adapt to the situation and understand the purpose of what academic staff are trying to achieve. Yung works only with year subject co-ordinators. Lack of time is an issue for academic staff. Yung observed:

> *There's never enough time. There's never enough time to actually provide the professional learning for people.*

Staff members can participate in professional development workshops regarding the use of case studies, different types of assessment practices and how they can distinguish between formative and summative assessments. For instance, one workshop is about the use of mid-session and final session multiple-choice exams. The application of the workshops is to consider matters such as when you use it, why you use it and what would be difficult for a student. As Yung explained:

> *I asked them to bring their exams that they set to the class, and they had to choose 1 or 2 of the questions and share them with the person beside them from a different discipline and then talk about whether they thought the actual choice was a good choice. And then we talked about what the research said.*

This kind of workshop engages staff to develop their own questions and to see the potential problematic issues might arise given the Faculty has a large number of international students. Although students may know the answer, the way questions are worded can make it difficult for them to understand the questions. Yung noted:

> *Staff started to realised how difficult it was to get that fine difference between the choices and also the difficulty that students might have.... they very quickly could pick up and say "Well I don't understand what this says and "wouldn't it be better if it was worded this way" so they looked at the way things are worded.*

The opportunities for using and implementing technology for staff and for development are quite exciting if staff would like to use the technology. Yung explained:

> *YouTube is another great one and there are a lot of really good sites that talk about where you can actually watch short videos about good teaching techniques and so on. And working from visual image has a lot of power in it that could be easily downloaded for them to look at whenever they need additional support.*

5.8 Conclusion

The University of Wollongong is committed to providing appropriate training to ensure employees, students, contractors and visitors have the skills and knowledge necessary to be at university. The approach to professional development at UOW is multilayered, with multiple units involved and multiple topic areas provided by a diverse range of staff. It is underpinned by policy and reward and recognition for excellence in teaching. As participant Quentin noted:

UOW has a successful strategy for developing staff in a context where innovation is encouraged and rewarded. The formal recognition of quality teaching by UOW leads to improved recruitment procedures.

The quality of the teaching and learning experience is one indicator that what we are doing is successful because we are either recruiting great teachers or we're developing them.

The variety of training topics is wide: technology, library, organisational knowledge, research development, workplace health & safety, career development and progression, professional development, finance courses, leadership and management development and student systems training and statistics. Policy stipulates the *University Learning and Teaching* (ULT) course as compulsory for all new academic staff. Gathering evidence as to the success of formal training is an integral component to conducting professional development.

Networks for academic staff are strong, enabling one of the main approaches to professional development, which is learning from each other's experiences. UOW builds opportunities where teams or individuals share their development journey, for them to reflect and share what they have learnt about themselves and their peers and what information they can give so that they may continuously manage better learning in the future. Many individuals forget that other peoples' experience and knowledge are a useful resource that may be very relevant and of great importance in developing countries where support is minimal and at times non-existent. This learning from others and learning with others can be very beneficial. As participant Doug noted:

Over the last 5 years I've learnt a lot from other colleagues here about new educational technologies that exist. About eLearning and edublogging, whatever it is… Just constantly watching what others are doing. Reflecting on that I try to implement things into my own practice evaluating that, discussing things with other people, running blogs so both face-to-face and online there are opportunities to talk to colleagues about what works and doesn't work.

Project work is widely used at UOW. For example, CEDiR achieves much through this, working side by side with academic staff. Projects include changing the curriculum, developing learning materials, and co-teaching with academics in their classroom. Project work is a particularly, effective way to help an academic staff member change the way they work because it is directly relevant to that academic's needs. As Quentin explained:

Working on projects with them is a much more effective strategy than just coming to a workshop ......Working within their offices at their desktop to have

> *discussions as we are setting them up technology wise. What are they trying to achieve pedagogically? It is much more effective, rather than talking to a group where 'one size fits all' and it doesn't.... If you want to create change then you have to work with people on the changes they want to make – supporting and mentoring them.*

Staff attend many professional development opportunities that exist at UOW and also those at other universities. There are many workshops, conferences, gatherings and opportunities for one-to-one meeting or with video conferences. Academic staff are supported through consulting, collaborating, advising, designing, researching, evaluating, sharing and reflecting. Other approaches to training staff at UOW, include face-to-face training sessions which include drop-in sessions, one-to-one consultations and group sessions. They are provided with print resources, together with contact details and web URLs so that if the staff member cannot attend to a face-to-face session, they can make use of published information allowing then to explore further according to their expertise. These can all be used in developing countries.

Staff also can request to undertake suitable training when it is available. Units also can consult with staff in different faculties and divisions, formally requesting development in relation to their needs. Indeed the professional development plan for most of the units providing professional development for general or academic staff depends on staff and university needs.

The use of technology makes it easier for staff to deliver lectures without them carrying the pressure about the use of that technology. Lecturers need support and to be well prepared for use of a variety of different technologies such as document cameras, projectors, video sources, computers, and videoconference. The workshops, run at UOW are particularly apt for raising awareness and for providing information to staff. They are also important for creating networks and this provides the researcher's starting point for professional development in Oman.

6 Case study: Professional development in the Middle East

The creation of a professional development program is initiated with an examination of the context for delivery in Libya and Oman. This account provides insights into the Libyan higher education sector and outlines several challenges that must be overcome before technology, such as eLearning, can be successfully introduced. These include teacher training, overcoming both cultural perspectives and poor infrastructure, and a lack of research, development and publication. Examining what is available in the University of Benghazi (formerly the Garyounis University) has allowed progress to be made towards understanding how the restrictions of limited infrastructure can be overcome.
This chapter also provides insight into the Omani education system including higher education, funding, information and communication technologies in higher education and the identification of professional development possibilities. In this study the participants including academic staff and staff developers in the Sultanate of Oman share their experience and perspectives regarding the integration of technology at university level.

6.1 Introduction

This case study was prompted by the bringing together of the technological and educational experiences of a Libyan graduate studying in a mathematics department in an Australian university with reflection upon the challenges of teaching in Libya. With the initial focus involving the challenge of introducing technologies to staff in developing Middle Eastern countries, the immersion process at the University of Wollongong (UOW) was used to identify best practices regarding the use and ease of use of technology in tertiary mathematics education. Taking advantage of what has been learned elsewhere was deemed important if the education gap between developing and developed nations is to be closed. The study itself sought evidence that it was possible to transfer these understandings of technology in the Australian context and embed their use in the new cultural context.

Earlier work at UOW included a national Australian Teaching and Learning Council project engaging staff in the development and sharing of mathematics learning resources (Porter & Denny, 2011). As part of this thesis, data were collected and documented (refer, Chapter 5) regarding how technology was used and supported in

teaching mathematics and statistics at UOW. From this research the technologies used in the SMAS were identified. In turn this led to identifying what could be adapted or replaced by alternatives (e.g. freeware), for use in developing countries. Possibilities in relation to professional development in the Middle East to enable technologies to be exploited in teaching and learning mathematics were identified. From the Australian context four initial topics were identified as best practices providing content for staff development mathematics educators. These topics were the use of the Tablet PC in lecturing, the use of the Tablet PC in the development of resources, designs for combining resources for learning management systems, and evidence based evaluation of student learning. The practices of staff developers at UOW were also examined with a view to identifying ways to introduce new technology to staff.

In this chapter is an analysis of the issues regarding the use of educational technology in Libya, the intended site for the implementation of the professional development program, along with a description of the program. The subsequent implementation of the package in Oman and the associated outcomes are then explored together with the prospect of the program being transferable to other nations.

6.2 Case study: Libya

The aim of this research was to identify ways to implement the best of western technology into developing Middle Eastern countries given their limited infrastructure, funding and available expertise. Libya, the birthplace of the researcher, was chosen as the location for an intervention through a professional development package. Qualitative methods were used to analyse the Libyan education system, from an experiential and documentary perspective, in order to compare it with the teaching and learning conditions in a mathematics department at a university in Australia. Three of the most notable resource differences identified were: Internet access, the use of eLearning systems and the variety of mathematics and statistical software available. The challenge was to identify an infrastructure which can be made available to support student learning, and in particular mathematics learning, in locations where there are few resources available. As discussed in Chapter 2, possible solutions were identified through an exploration of

the components and functionalities of the technologies. This included the use of open source software and some features of the Internet, for example html and web browsers, which allow reshaping of how educational materials are organised and made available to students. It was also apparent that professional development would be a key part of the solution.

6.2.1 The Libyan educational system

Both before and after the conflict that erupted in Libya in February 2011 education was free for citizens up to and including undergraduate university courses. However, in 2012 the school and tertiary curriculum began to change. For example, the 'Green Book' (Gaddafi, 1975), consisting of three parts: 'The Solution of the Problem of Democracy: The Authority of the People (1975)', 'The Solution of the Economic Problem: Socialism, (1977)' and 'The Social Basis of the Third International Theory, (1981)' have been removed from the curriculum.

The education system consists of several stages (refer, Figure 6.1). All levels of education have two semesters per year. The primary stage begins at age six, continues for six years and is compulsory. Children may be educated in public or private schools or at home. The institution that monitors home education provides free text and course books and also gives financial assistance to parents. There were approximately 10,140 students registered for home education in the academic year 2007-2008 (The General People's Committee of Education, 2008).

Preparatory school, or middle school as it is also known, is compulsory. It lasts for three years and finishes with a national examination. Home schooling is not possible for preparatory school.

In the third stage, students attend a high school (general or specialised), an intermediate vocational centre or a teacher training institute. There are three types of general high school: arts, science and technology. There are also specialized high schools in agricultural sciences, basic sciences, engineering and industrial sciences, economics, fine arts, media, medical sciences and social sciences. Studies last for three years in general high schools and vocational centres, four years in specialized high schools and five years in teacher training institutions. In all institutions the final year finishes with a national examination. Successful candidates receive either a

General High School Certificate or a diploma, depending upon the type of institution attended (Clark, 2004). Students who pass high school with sufficiently high marks can advance into higher education.

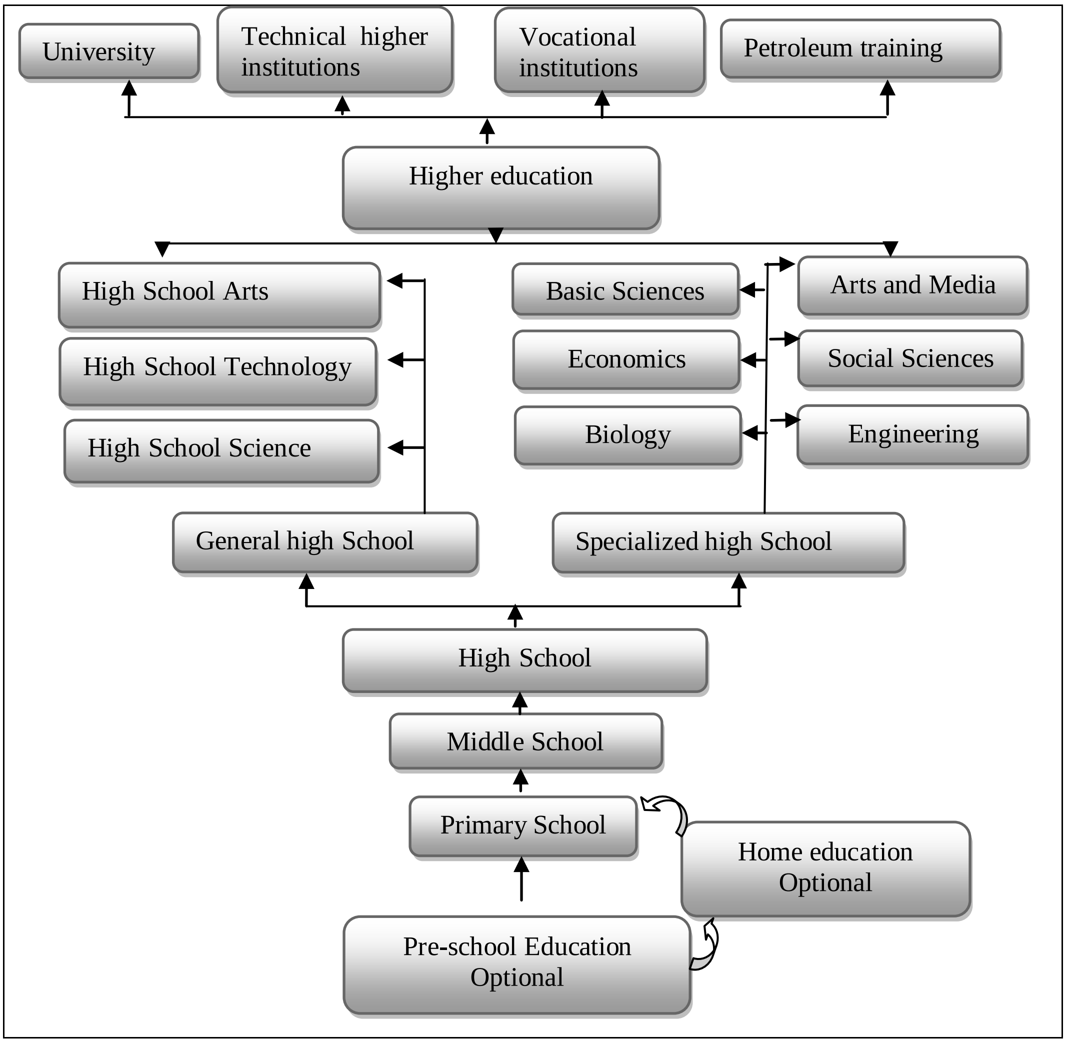


Figure 6.1 Structure of the education system in Libya

6.2.2 Higher education in Libya

The higher education system contains a variety of institutions. These include public and private universities, an open university, technical higher institutions, vocational institutions and also training and qualifying institutes for the petroleum industry (Arabsheibani & Manfor, 2001). The undergraduate higher education system is financed predominantly by the state: students pay tuition fees only at the Open University and at private universities.

The writer is a lecturer at Garyounis University, the site where the civil war broke out. This was renamed the University of Benghazi after the conflict. This relatively

young university is the oldest university in Libya; its antecedent was an art college founded in Benghazi in 1951.

The university has grown to include several campuses offering undergraduate courses requiring four to five years of full-time study. Post-graduate studies are not free but are subsidized. Masters studies are of two-to three-year duration. Following completion of a master's degree, a doctorate requires three years of research. Comparatively few students receive PhDs from Libyan universities and these are mainly in fields such as Arabic, Islamic studies and the humanities. Libyan universities have not yet started doctoral programs in science, technology or engineering. Most academics have doctorates or masters degrees received from foreign universities (Clark, 2004).

The Open University established in 1990 in Tripoli now has 16 campuses around the country. It awards bachelor level degrees, with resources in the form of printed materials (Clark, 2004).

Higher technical and vocational institutions were established in 1980. These include: higher teacher training institutes, higher vocational centres and specialized higher institutes for technical, industrial and agricultural sciences. Higher institutes offer programs in fields such as computer studies, civil aviation, electrical engineering, finance, industrial technology, mechanical engineering, medical technology and social work. After three years study at vocational institutes and centres a Higher Technician Diploma is awarded, or after four to five years study a Bachelor degree is awarded (Clark, 2004). Student fees are very small. Students pay only registration fees at the beginning of the academic year or semester (EACEA, 2012).

At the petroleum training and qualifying institutes, trainees and employees within the oil and gas sector take courses leading to *City and Guilds* qualifications of the London Institute (Clark, 2004).

6.2.3 Challenges in the higher education sector

Prior to the conflict, the Libyan higher education sector faced the challenges of significant reform and it continues to face this. Under a five-year national strategic plan, costing US$9 billion, universities are engaging in structural reforms to become

more efficient and effective in providing learning and support for students (Sawahel, 2009). The strategy includes the establishment of a *National Authority for Scientific Research* (NASR) to help build scientific capacity, and a *Centre for Quality Assurance and Accreditation* (CQAA) to evaluate the academic performance of the education system according to international performance standards (Sawahel, 2009). Libyan universities face challenges to improve the quality of education services, and the efficiency of education expenditure and to introduce new teaching and learning methods. These challenges include the provision of better teacher training and qualifications and finding mechanisms for adapting eTechnologies.

6.2.3.1 Teacher training and qualification

Teachers are at the core of education reform and it is important to provide them with opportunities for professional development in the use of educational technology (Danwa & Wenbin, 2010). A lack of training has resulted in teachers using traditional "chalk and talk" methods that do not help students learn how to think. Consequently, there has been a tendency for them to learn by memorisation rather than by reasoning and meaningful learning (The General People's Committee of Education, 2008).

Despite the increase in expenditure by the Libyan National Education Department, there are limitations as to what can be achieved. For instance, teachers have little experience of modern educational methods which implement strategies to build skills and to engage students in thinking and analysis or even in using technology. In order to fill and correct such gaps appropriate training needs to be identified through research, delivered in stages and the outcomes evaluated to ensure that the training needs have been met (Jamil & Som, 2007).

Teachers should be helped to understand how educational technology can inform and improve pedagogy and, as a result, contribute to improved student performance (UNESCO, 2005a). A lack of adequate awareness of instructive technology is common among educators and students in Libyan higher education institutions (Rhema & Miliszewska, 2010). Academic staff and students in Libya are generally not conscious of the potential of the resources and the support that they can obtain via an eLearning site or web environment.

With respect to the integration of technology into teaching, there are several issues for Libya. The first of these is that the level of educational technology knowledge and basic computer skills among lecturers in the higher education sector is low. This has led to reluctance to adopt ICT for teaching (Rhema & Miliszewska, 2010). Libyan academic staff need to be trained in both the use of new technology, so that they become familiar with it, and the effective use of it in teaching.

6.2.3.2 Adopting eTechnologies

The Internet first became available at state institutions in Libya in the mid-1990s, expanding to public access in 1998. However, prices were excessively high and access was limited. This had, and continues to have, implications for the adoption of eLearning system into teaching practice.

International cooperation can have a positive impact on the adoption of eLearning systems and education reform. Pre-conflict, through the support of UNESCO and the curricula provided by developed countries, Libya was moving towards the integration of ICT into educational systems. This included the trial of eLearning system with Blackboard, provided by an international company, in six schools in Tripoli for mathematics and English subjects (The General People's Committee of Education, 2008). The eventual aim of this project was to expand the course management system to all subjects and to all levels of education. There was other evidence of progress in adopting eLearning system for use in higher education to support and engage student learning (The General People's Committee of Education, 2008). Change since the Arab Spring is difficult to ascertain.

The recent study by Rhema and Miliszewska (2011), in the Aljabal Algharbi University in Libya, indicated that the eLearning system initiative with respect to communication, group-work, assessment, and feedback was positive, even though technical support was reported as a minor concern due to limited expertise and availability of the technical staff. Both students and instructors stressed its positive impact on student learning outcomes when comparing the results during the beginning of the semester (before the trial) with the same students in the same course when only face-to-face sessions were used. Technical staff suggested better induction training for students and staff and better ongoing technical support was required from the system vendor (Rhema & Miliszewska, 2011).

6.2.4 The future of ICT and education in Libya

In 2004 a range of embargos and restrictions that were imposed upon Libya were removed. This set the stage for stable and sustainable development. With the return of international relationships with the United States, Europe and other countries there came a new national policy and international cooperation to enhance the future of ICT and education. In 2005 UNESCO signed an agreement with Libya to cooperate in a 'National ICT Project for Capacity Building' (UNESCO, 2005b). This project included the organization of Local Area Networks within all 149 faculties belonging to diverse university campuses and institutes. It also involved the formation of a Wide Area Network forming the 'Libyan Higher Education & Research Network'. It also foresaw the creation of digital libraries/portals of educational resources and the development of ICT-enhanced learning solutions such as eLearning system and tele-education (UNESCO, 2005b).

The former Libyan government was determined to provide tools and ICT skills to all sectors of the country, particularly the education sector. Sawahel (2009) reported that: 1) by June 2008, all 1.2 million Libyan school children had received a laptop; 2) despite the government's efforts to supply computers to primary and secondary schools considerable challenges remained, including restricted Internet access and a shortage of teachers who knew how to integrate computers into learning; 3) a program for training teachers and higher education staff in the use of ICT was implemented; and 4) policy sought to improve the quality of learning in higher education, open and distance learning by adapting modern techniques and methods in education. The strategy included a $US72 million project to use ICTs to reform the higher education and the scientific research system by integrating ICTs in education and science. The project foresaw the creation of a national ICT resource centre for educators and the automation of university management systems through ICTs such as student information systems, university procedures, financial operations (Hamdy, 2007). Despite all these efforts, the integration of ICT in the Libyan education system remained limited and at an early stage (Rhema and Miliszewska, 2010).

6.2.4.1 Artifact analysis

Artifact analysis involved translating from Arabic to English the requirements for the Bachelor of Science degree (BSc) and the description of BSc course available

through the mathematics department at University of Benghazi (Garyounis) and comparing this with subjects offered at the University of Wollongong. Mapping the subjects from the University of Benghazi and the University of Wollongong, allowed the alignment of subjects in the two countries in terms of desired outcomes/topics and hence the potential for software use and the opportunities to identify available technology to introduce technology to Libyan staff. This comparison revealed that while many topics taught are the same in both countries, the way they are grouped into subjects is quite different. The requirements for the BSc from Libyan Department of Mathematics is at least 130 credit hours of mathematics. The core first year subjects are described in Table 6.1, with indication, where possible of the subjects where topics are taught at UOW.

Table 6.1 Core 100 level Libyan Mathematics subjects

Subject Details Taught at UOW	Topics Taught
1100 General Mathematics I 4 credits, No prerequisites UOW MATH187 topics	Cartesian coordinates, distance between two points, division of Line segments, slope, angle between two lines, parallel and perpendicular of lines, equation of lines, distance from point to line, standard equation of circle, parabola, ellipse and hyperbola, set and subsets, basic set operation(Union, intersection, difference), real line, order , intervals, inequalities and absolute values, Cartesian product of two sets, relations and functions, domain and range of function, graph of functions, composition of function, one to one and onto functions, inverse function, limits, one side limits and continuity, derivative, differentiation of algebraic function, chain rule, parametric equations and higher order derivative s , differentiation of trigonometric , inverse of trigonometric , exponential and logarithmic functions application of derivative: tangent and normal, differentials related rates maxima and minima curve tracing.
1101 General Mathematics II 4 credits, Prerequisite: 1100 MATH188 topics MATH187 topics	Hyperbolic Functions, Rolles and means value theorems with applications, generalized (Cauchy) me and value theorems L'Hospital's rules and indeterminate form, extended mean value theorem, and Taylor's explanation formula, approximation and error, standard Taylor's series of expX , sinX, cosX, 1/(1-x), mean value theorems and Newton method for approximating solutions of equations, indefinite integrals, definite integrals and fundamental theorem of calculus, mean values theorem for integral , differentiation under integral sign, the various techniques of integration, improper integrals, integration of indefinite integral, application of define I integral: arc lengths, area, value, area of surfaces of revolution.
1110 Analytic Geometry Credit 3 No prerequisites MATH187 topics	Vectors in plane and space (sums, differences, norms, direction, inner product). Straight line, circle, conic sections, transformation, rotation and general second degree equations of plane, curves, surfaces (sphere, cylinder, ellipsoid, parabolic), transformation of coordinates in space, cylindrical and sphere coordinates, equations of straight line and plane.

*Note 1: all subjects compulsory

*Note 2: There is an overlap of subjects taught at UOW through the subjects

The core 200 level Libyan subjects, (refer Table 6.2) include topics which are covered at 100 level at UOW.

Table 6.2 Core 200 level Libyan subjects

Subject details	Topics taught
1200 Calculus I Prerequisite: 1101 MATH187 topics MATH188 topics	Sequences and infinite series, tests of convergence, power series, Taylor's series with remainder, polar coordinates curve tracing, conic sections, angle between vector and tangent line, length of curve, arca of region in polar coordinates, Cartesian and polar forms of curvature, functions of several variables: limits, continuity partial derivatives, tangent plane, normal line, maximum and minimum, method of Lagrange multiplies, higher order derivatives.
1201 Calculus II Prerequisite: 1200 MATH188 topics	Integrals calculus of functions of several variables, multiple integral, double and triple integral, in Cartesian, polar, cylindrical and spherical coordinates. Applications and double and triple integral for calculating mass, area, volume, surface area, center of mass, moment of internal, line integral , dependence on path, vectors , differential operators (grade,div,curl) and relative formulas . Theorems of Green, Gauss, and Stokes. Fourier series, half range series.
1202 Differential Equations I Prerequisite: 1101 MATH188 topics	Ordinary differential equations, basic concepts, separable equations, homogeneous equations, exact equations, integrating factors, linear first order equations of second order, fundamental theory of solution, solution of equations with Constant coefficients, homogeneous equations. Particular solution of non homogeneous equations, method of undetermined coefficients, equations with constant coefficients of higher order, solution of equations with variable coefficients, method of variation of parameters, application of second order equations.
1203 Complex Analysis 1 Prerequisite: 1200 MATH187 topics MATH188 topics	Complex numbers, function of complex variables, limits and continuity, sequences and series of complex numbers, analytic functions, elementary functions and mapping by them, conformal mappings, complex line integral, Cauchy-Goursat, theorem and Cauchy integral formula (without proofs).
1204 Mechanics I Prerequisite: 4101-1101	The axioms of mechanics, static of partial, vectors, composition, and resolution of concurrent forces in plane and forces in space, equilibrium of particle in plane and in space, centre of mass and centre of gravity of some common bodies, theorems of Papas-Guldinus, centre of mass, composite bodies. Rigid body, equivalent system of forces, moments of force, a moment of Couple, reduction of system of forces friction, coefficient of friction, angle of friction. Differentiation of vectors, velocity and acceleration, rectilinear motion of particle, simple harmonic motion. Curve line motion of practical, motion of projectiles, circular motion, momentum of energy, work, power, kinetic and potential energy, and principal of impulse and momentum.
1205 Theory of Equations and Theory of Numbers Prerequisite: 1101 Compulsory MATH188 topics MATH121 topics	Divisibility, prime and composite numbers, fundament theorem of arithmetic, greatest common divisor and least common multiple. Congruencies and their properties, complete residue system and reduced residue systems. Euler □-functions, computation of □(n). Theorems of Euler, Fermat and Wilson. Solution of linear congruence, Chinese remainder theorem, quadratic residues. Basic properties of polynomials, algebraic equations, roots and coefficients, symmetric polynomials and Newton's formula, rational roots and complex roots of certain equations by radicals of cubic, quadratic and reciprocal equations. Case of equations of degree >5 (statement only). Separation of roots and Sturm's theorem. Approximation of real roots (Newton's method).
1206 Calculus and Differential equations Prerequisite: 1101 MATH188 topics	Integration of trigonometric function, relation and inverse function, trigonometric and exponential function. Multiple integrations, limits and continuity, partial derivative, implicit differentiation, Chain rule application, hyperbolic functions, and inverse hyperbolic functions, equations of first order and first degree, Separable equations, homogeneous equations, linear equations, exact differentials, application of first order equations, second order equations with constant coefficients, application of second of order equations, other second order equations.
1207 Fundamentals of Mathematics Prerequisite: 1101 MATH121 topics	Mathematical logic, statement calculus and predicate calculus, rules of inference, logical equivalence and logical implication, proof and method of proof, direct and indirect proof set theory and subsets, set operation, ordered pairs and Cartesian product. Relations, equivalence relations, equivalence classes and partitions, ordering relations, partial, total and well order, supremum and infimum elements, functions, one to one and onto properties, composition and inverse functions, image and inverse image of sets, binary operations, types of binary operations, finite and infinite sets, countable and uncountable sets, integers, divisibility and congruence relations, residue and reduced residue classes, rational and irrational numbers, decimal representations of real numbers.

*Note 1: all subjects are worth 3 credit points and all subjects are compulsory
*Note 3: There is an overlap of subjects taught at UOW through the subjects

The core 300 level subjects, (refer, Table 6.3) are also different in terms of the grouping of topics when compared to subjects at UOW.

Table 6.3 Core 300 level Libyan subjects

Subject	Topics
1300 Linear algebra Prerequisite: 1101 MATH187 topics	Matrix algebra: elementary row operations, rows Echelon and row-reduced Echelon form, rank of Matrix, inverse Matrix. Determinates: properties and computations. Classical adjoint and inverse matrix. System of linear equations, homogeneous and non-homogeneous, Crammer's rule. Vector space, linear independence, basis and dimension, linear transformations and matrices. Change of bases for vectors and linear transformations: similar matrices, eigenvalues and eigenvectors, Cayley-Hamiliton theorem. Diagonalization of matrix, inner product spaces, orthogonal bases, Gram-Schmid theorem. Bilinear forms , quadratics forms, Hermition forms and normal forms.
1301 Abstract algebra Prerequisite: 1300-1207	Groupoid, semigroup, definitions and examples, groups, examples and important deducation form definition, subgroups, Lagranges's theorem, cosets, normal subgroups, cyclic groups and their properties, Homomorghism and isomorghism of groups, , Homomorghism and isomorghism theorems, permutation groups in details, rings, division ring, field and integral domain , definitions, examples and elementary properties ideals, maximal and prime ideals, quotient rings from ring if integers Z, homomorghism and isomorghism of rings, polynomial rings over fields.
1302 Differential equations II Prerequisite: 1202-1200	Series solution of second order equations, Taylor series, Forbenius methods. Bessel and Legendre equations, methods of Laplace transform, system of equations, existence and uniqueness theorems for first and second order equations (statement and illustrations only). Finite difference equations, partial differential equations of first order.
1304 Mechanics II Prerequisite:1204	Attraction and potential at point due to some common bodies, gravitational potential energy, moments of inertia of some common bodies, , parallel and perpendicular-axes theorems, moments of inertia of composite bodies, product of inertia, principal axes and principal moments of inertia, ellipsoid of inertia. Forces in beam and distributed loads, parabolic cable, methods of virtual work, potential energy and equilibrium, stability of equilibrium, d'Alembert's principle. Angular momentum of particle, equation of motion of particle equation of motion of particle terms of radical and transverse components. Motion under central force, Kepler's laws of planetary motion, impulsive motion, impact, oblique central impact, moving coordinate system, velocity and acceleration in moving system.
1306 Real analysis I Prerequisite: 1207-1200 MATH188 topics	Axiomatic description of real numbers as complete order field, Archimedean property, dense properties of rationales and irrationals, limit points and Bolzano-Weierstrass theorem (statement only), sequences and series of numbers, convergence, theorems and sets, limits, continuity and convergence, uniform continuity, intermediate value theorem. Derivative and its properties, mean value theorems, implicit function theorem (without proof), Riemann-Stieltjes integrals and their properties.
1309 Differential & Transformational Geometry Prerequisite: 1301-1201	Vector function of real variables (limits, continuity, and derivative), curves in (equivalent representations, arc-length and natural representations), unite tangent vector, curvature, principal normal vector, binomial moving Trihedron, torsion, Frenet equations, the fundamental existence and uniqueness theorem for curves in Rn.. Transformations and geometric transformations, groups of invariance, Euclidean transformations (isometries), rotations and glide-reflections, basic properties of isometries, analytic and matrix representations. Euclidean group and its basic subgroups, Euclidean invariant, similarities (homotheties), properties and analytic representations, similarly group, affine and projective transformations, their groups and invariant, topological transformations, Klein's concept of geometry, inverse geometry, analytic representations of invariant, elementary facts of plane geometry proved be transformations
1310 Topology I Prerequisite: 1306	Metric space, open ball and open set , topological space, closed set, neighborhood, Hausdroff space, interior, limit, closure and boundary points of set, Bolzano-Weierstrass theorem (statements and examples), continuity, homeomorphism and topological properties, subspace, finite product space, quotient space, brief account on connectedness, path-connectedness.
1312 Foundation of Geometry Prerequisite: 1300-1207-1101	Euclid's original system and its effects, axiomatic method, proof of diagrams, Hilbert's axiomatic system of Euclidean geometry, brief construction of elementary geometry, advanced Euclidean geometry of triangle and circle (Menalau's and Cave's theorems, nine point circle). A brief historical survey of axiom of parallelism. Hyperbolic geometry up to proving that angle sum of triangle $< \pi$. Elliptic geometry up to proving that angle sum of triangle $> \pi$, models and consistency of non- Elliptic geometry, measurement of non- Elliptic geometry, projective plane, principle of duality, Desargues' theorem and Pappus's theorem (statement and diagrams only). Quadrangle axiom, separation axiom of continuity, homogeneous coordinates, projective line and cross ratio, subgeometries (Affine, Euclidean, hyperbolic and elliptic) of projective geometry

*Note 1: all subjects are 3 credit points and compulsory There is an overlap of topics taught at UOW.

At 400 level Libyan students must complete three core subjects (refer, Table 6.4). Students at the University of Wollongong do not have a fourth year unless they are completing honours.

Table 6.4 Core 400 level Libyan subjects

1401 Abstract algebra II Prerequisite: 1301	Direct products of groups , Abelian groups, Sylow's theorem, free groups, field of fractions of integral domain, characteristic of ring, principal ideal and Euclidean rings, factorization, zeros of polynomials
1406 Real analysis II Prerequisite: 1306 MATH188 topics	Sequences and series of functions, Point-wise and uniform convergence, uniform convergence and properties of continuity, derivative and integration, power series, uniform approximation and Weierstrass approximation theorem, measurable sets and functions, Lebesque integral and its properties, convergence theorems, relation of Lebesque and Riemann integrals , L^p- space and Minkowski inequality.
1450 Graduation Project	Topics will be selected from the areas of interest of staff members and students

*Note 1: all subjects are worth 3 credit points
*Note 2: all subjects compulsory
*Note 3: There is an overlap of subjects taught at UOW through the subjects

Students need to finish up to 78 credit hours, 66 credits compulsory courses from mathematics major course and up to 12 credits from mathematics electives courses. (refer, Table 6.5).

Table 6.5 Elective subjects (12 credits hours)

Course code	Course Title	Credit	Prerequisites
1303	Complex Variables II	3	1203
1307	Mathematical Methods I	3	1300-1203
1311	Number Theory I	3	1205
1316	Differential geometry	3	1310 – 1309
1400	Linear Algebra II	3	1300
1402	Partial differential equations	3	1302-1201
1404	Mechanics III	3	1304
1405	Integral equations	3	1302-1201
1407	Mathematical Methods II	3	1302-1203
1408	Romanian Geometry	3	1300 -1207-1201
1409	Modern Analysis	3	1406
1410	Topology II	3	1310
1413	Axiomatic set theory	3	1207
1417	Fluid Mechanics	3	1304-1201
1418	Theory of Elasticity	3	1304
1419	Bio mathematics	3	1309-1302
1421	Field theory	3	1401
1430	Combinatorial Theory	3	1301
1431	Graph theory	3	1301
1432	History of mathematics	3	1406
1433	Mathematical Logic	3	1207
1440	Independent study I	1	---
1441	Independent Study II	2	---
1442	Independent study III	3	---

Students also have to select supported courses with 37 credits hours. These courses consist of two groups, the first one of which are obligatory (25 credits hours) (refer, Table 6.6). One of these *2109 General Statistics* was until 2009 was taught without

software, it could however be taught using the freeware software package R, or even possibly the commonly available, Microsoft Excel. In 2009 the researcher left Libya to study in Australia.

Table 6.6 Obligatory subjects

(i) Obligatory courses (25 credits hours)			
Course code	Course Title	Credit	Prerequisites
2102	Elements of probability I	4	---
2109	General Statistics	4	---
4101	General Physics I	3	---
4102	Practical Physics I	1	---
4103	General Physics II	3	4101
4104	Practical Physics II	1	---
9103	Introduction to Computer Science	3	---
9104	Introduction to Computer Programming	3	9103
9204	Numerical Method I	3	9103 -1200

In addition to the obligatory subjects students must choose one of the special sequences from outside the Department from optional 12/13 hours courses as listed (refer, Table 6.7). All students in the Faculty must also study (13 credits) Arabic, Political Thought and English.

Table 6.7 Optional subjects

(ii)Optional courses 12/13 hours			
Statistics (14 credits)			
Course code	**Course Title**	**Credit**	**Prerequisites**
2106	Elements of probability II	4	2102
2107	Statistical methods	4	2109-2102
2207	Mathematical Statistic I	3	2106
2307	Mathematical Statistic II	3	2207
Physics (13 credits)			
4202	Waves and oscillation	2	4103
4203	Thermodynamics and kinetic theory	2	4103
4204	Physics Practical III	2	---
4212	Electrical and magnetism	3	4103
4214	Alternating current Theory	1	4212
4301	Atomic physics and special theory relativity	3	4103
4202	Waves and oscillation	2	4103
Computer science (12 credits)			
9201	Design of digital computer	3	9104
9205	Pascal programming language	3	9104
9302	Introduction to assembly language	3	9104
9311	Data structures & application	3	9205_1207

Even though there is a difference in terms of the subject offerings and current use of statistical and mathematical packages, there are substantial overlaps comparing the degree in terms of topics taught.

At UOW the software packages Excel, Maple for algebra and differentiation and Models, Matlap for Linear algebra, SAS, SPSS, JMP and R, are used in a few subjects, but not extensively. Given UOW practice, there is an opportunity for the

Libyan system to add in terms of software use and resources. In Libya it is likely that the freeware software packages SAGE, Maxima and R would be suitable for use in some of the 100-400 level subjects.

6.2.5 Package for professional development

The process of adoption of technology by university staff passes through three general stages: technology as a support function, technology used in teaching, and technology use resulting in fundamental change in both classroom structure and behaviours (Celsi & Wolfinbarger, 2002). Celsi and Wolfinbarger discuss not only the degree of sophistication of technology, such as the Internet, wireless and various software and hardware that produce cultural/behavioural change, but also the evolution of its use through experimentation. Technology can make it easier to teach material in routine ways and it has the potential to adapt new, arguably better, approaches to instruction or to change the content or context of learning (Lawless & Pellegrino, 2007). Professional development in software and tools or learning how to use technologies, such as browsers or videos, can help integrate technology into teaching and learning (Lawless & Pellegrino, 2007). Techniques that can be used to raise awareness and change attitudes also include 'formally organized awareness programs, visits to similar institution where success has occurred and short trainings.' (Sife et al., 2007, p. 63). The challenges are not just the need of computers but of managing resources productively. A significant challenge is how best to keep staff informed of what is available, and how to provide access to hardware and software (Williams, Richardson, Wilson & Tuson, 2000). An important component of IT plans to effectively integrate it into mathematics teaching and learning is to educate lecturers in the pedagogy of using IT in teaching practice and student learning, rather than focussing merely on the acquirement of IT skills (Koh & Koh, 2006)

To achieve an effective use of ICT in teaching Williams et al. (2000) categorises teachers' ICT development needs into the three areas shown below (refer, Figure 6.2). To keep pace with technology it is important to improve the capacity of departments to use technology, to train the next generation of teachers to use technology in their classrooms, and to retrain the current teaching workforce in the use of technology-based instructional tactics (Lawless & Pellegrino, 2007).

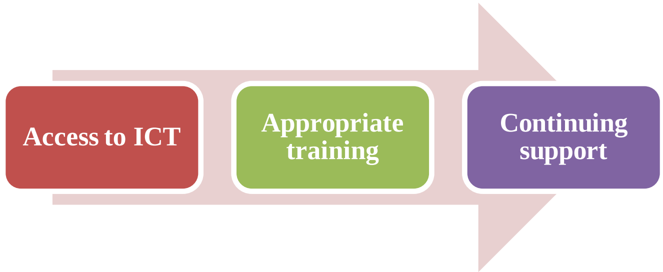


Figure 6.2 Teachers' ICT development needs

UOW offers a variety of professional development activities for both academic and general staff through an annual training calendar in order to enhance staff knowledge, skills and attitudes relevant to their current work.

The workshop training session for professional development and hands-on practice in Libya and Oman covered four topics.

1. Learning design. Participants were provided with: A definition of learning design; three examples demonstrating ways to combine mathematics learning resources for subjects in eLearning; and, a web-based learning resource used in several subjects at UOW, namely *Summertime Math* (http://www.math.uow.edu.au/subjects/summer/topics/fractions.html).
2. Evaluation. Two examples of evidence based evaluation to guide change.
3. Use of a Tablet PC in lectures. The topics included: An introduction to touch-screen tablets; choosing the best software for a topic; and, inking (writing) in different software packages such as PowerPoint, Microsoft Word, PDF annotator, Windows Journal and Sticky Notes.
4. Resource generation. The introduction to resource creation involved using the Tablet PC and Camtasia Studio software to create video resources. Subtopics included: Introduction to different video genres; how to record with Camtasia Studio; how to edit projects, including features such as zoom-n-pan, split, cut unwanted video and audio on the timeline, add transitions, add title clips, audio enhancements, save and produce in a variety of formats.

6.2.6 Post-war

Even in such devastation, good can emerge. Libya's post-conflict transition is underway, as Libyans work to consolidate change from the 40-year dictatorship to a representative democratic government (Blanchard 2012). Post conflict, for some at

least, views regarding technology are likely to have changed. The researcher's perception that awareness of the uses of the Internet in Libya is now changing is supported by a recent report (Freedom House, 2012). Since the conflict it has been my experience that Libyan people are more inclined to use the Internet; certainly it was a vehicle for information about the conflict being accessed and released.

Political changes have been reflected in the Internet freedom landscape resulting in a relatively open online information landscape since the rebel victory in October 2011 (Freedom House 2012). For example, while much infrastructure is now in ruins many people have discovered the power of the Internet as a means of communication. During the conflict Internet access via ADSL or WiMAX became free throughout the country from November 2011 until March 1, 2012, for those with functioning equipment (Freedom House, 2012). This considerably increased the number of users and hours spent online. Pricing structures then returned and as of May 1, 2012, Internet was available via mobile phone, landline, and cable networks throughout for those who had modems and SIM cards (Freedom House, 2012). Since the Arab Spring the Internet has become more affordable and accessible to individuals (Freedom House 2012). By early 2012 restrictions had loosened considerably and freedom of expression was flourishing. As of May 2012, social media applications such as the video-sharing website YouTube and micro-blogging services such as Twitter were freely accessible. Since the conflict Facebook, Twitter, and other digital media have grown in popularity and been used to mobilize Libyans for activism around a variety of causes. By April 2012, Facebook use had doubled to around 400,000 people, and the social networking tool was the most visited website in the country (Freedom House, 2012).

One of the issues identified as hindering the introduction of technology was attitudes toward the use of technology. A change in these attitudes is potentially a positive outcome in terms of future attempts to introduce technology to tertiary classrooms.

Section 6.1 and 6.2 provide insights into the Libyan higher education sector and outline several challenges that must be overcome before technology, such as eLearning, can be successfully introduced. These include teacher training, overcoming cultural perspectives and poor infrastructure, a lack of research, development and publication and maintaining political stability. Examining what is

available in the University of Benghazi (Garyounis University) has allowed progress to be made towards understanding how the restrictions of limited infrastructure can be overcome.

6.3 Case Study: Sultanate of Oman (Oman)

The researcher sought to find a place where there was a similar culture and economy, but which was more stable and safer. In seeking to deliver the package in Oman ideas of transferability between Middle Eastern countries emerged. It was considered likely that the program developed for use in Libya would be transferable for use in another country if the contexts were similar (refer, Figure 6.3). Reflection upon the Australian, Libyan and Oman contexts allowed for identification of the strengths and weaknesses in terms of offering professional development, particularly to middle-eastern countries, with a view to improving mathematics education through the use of technology. To this end the Omani culture, educational system and readiness for technology were explored and contrasted with that of Libya.

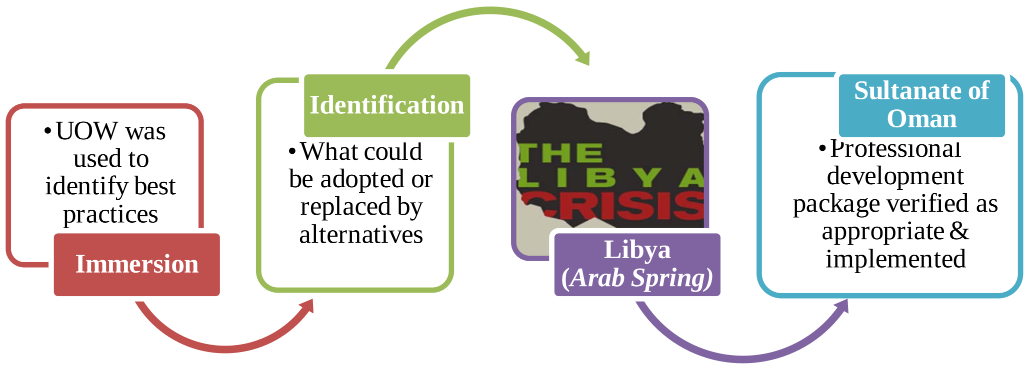


Figure 6.3 Implementation of professional development

6.3.1 The Omani education system

As for Libya, the public education system in Oman is free for citizens at all levels from grade one to university. The Government provides free books and transportation for children in the school system. The education system consists of basic education (BE), post-basic education system or vocational education, and higher education as detailed in (refer, Table 6.8).

Table 6.8 Education system in Oman.

Education level	Years of study	Description
Basic Education (BE): Primary	6	▪ The first 6 years of basic education are similar in concept to Western primary schools.
Middle (Intermediate Education)	4	▪ Three years of upper basic education follow. Individual students may complete their education at this point and seek work or, depending on their grades, they may go on to secondary school.
Post-Basic Education system (Secondary Education)	2	▪ Lasts for three years. After 4 years of middle school, students have the option of specializing in either the sciences or the arts, provided that their school results confirm their aptitude. Both programs result in the award of a secondary school leaving certificate.
Higher Education Vocational Education	1 to 3	▪ Provides opportunities for basic school leavers in need of professional training which lasts from 1 to 3 years.
Tertiary	5	▪ There are public & private universities & colleges

6.3.2 Higher education in Oman

Prior to 1970 there was no formal higher education in Oman. Higher education at Sultan Qaboos University (SQU) can be characterised by an establishment phase (1970s-1980s), with an emphasis on vocational education and training particularly in teaching and health followed by a phase where foreign programs were imported and delivered in Oman through private higher education institutions (HEPs) (colleges and universities) (Baporikar and Ali Shah, 2012).

As in Libya, over the past few years, there has been a diversification of program offerings in higher education in Oman. This has occurred both through new specialised institutions and through changes and additions to the spectrum of programs offered by established colleges. Higher education is provided by: one public university, several specialized institutes, technical and vocational colleges, teacher training colleges and other private institutions (Al Shmeli, 2009, Arabian campus 2013) (refer, Table 6.9). The Libyan system has more public universities and institutions reflecting a larger population (6.4 million people for Libya and 3.314 million for Oman), and a country larger in size, 1.8 million square kilometres for Libya and 309,500 square kilometres for Oman, with the economy of both countries petroleum based.

Table 6.9 Government and private higher education institution in Oman

Institutions under the Jurisdiction of	Higher Education Institution
Independent (1)	(1) Sultan Qaboos University (Government)
Ministry of Higher Education (30)	(6) Colleges of Applied Sciences (Government) (5) Private Universities (19) Private Colleges, two of which are designated as University Colleges
Ministry of Manpower (7)	(1) Higher College of Technology (Government) (5) Colleges of Technology (Government) (1) Oman Tourism College (Private)
Ministry of Health (16)	(11) Nursing Institutes (Government) (5) Health Science Institutes (Government)
Ministry of Defense (5)	(4) Academies/Training Centres and (1) Command Staff College (Government with restricted admission)
Ministry of Awqaf and Religious Affairs (1)	(1) The Institute of Shari'a Sciences (Government)
Royal Oman Police (1)	(1) The Royal Oman Police Academy (Government, with restricted admission)
Central Bank of Oman (1)	(1) The College of Banking & Financial Studies (Quasi-Government)

Source: Adapted from Al Shmeli, (2009, p.3).

Over the past two decades, there has been a significant increase in the number of students applying for overseas studies. Such students are either privately supported or on a government scholarship. This development may be due to the increasing awareness of the importance of higher education to personal advancement in the context of a global world economy (Al Shmeli, 2009).

6.3.3 Challenges in Omani Education

Challenges facing the Omani education include the need for teacher training, the provision of professional development and better ways to adopt eTechnologies

6.3.3.1 Teacher Training

The case study took place at the only public university in Oman, Sultan Qaboos University (SQU), a relatively new institution established in 1986. It is the only public university in Oman. Investigation into professional development at SQU by Al-Washahi (2007) found that there was no structured form of program or plan with a clear vision, goals, and strategies for educational technology development, even though the Academic Council of SQU approved a plan for a series of professional development workshops in 2001 (Al-Musawi, 2008). The evaluation study by Al-Musawi (2008) based on a total of 66 (41.2%) participants from 160 faculty members undertaking professional development workshops at SQU over the years

2002-2005 concluded that the professional development workshops at SQU need improvements in terms of,

> *…planning (materials selection and distribution; selection of competent presenters; and audience analysis), implementation (flexibility of the program; availability/relevance of materials/resources; and continuous formative feedback), and evaluation (summative/systematic feedback; and continuous review and follow up of materials/resources) (Al-Musawi, 2008, p. 13).*

In relation to Omani staff, there is a need for less expensive technologies but more in-service training, technical and human resources to increase the use of these innovations (Al Musawi, 2007). It was recommended that SQU staff members be provided with professional development to develop their skill using Moodle in order to enable them to move more easily towards providing a web-based learning environment (Al-Ani, 2012). It has been further recommended that intensive systematic in-service training programs should be conducted for staff in areas of new educational technology design, production, use, and evaluation (Al-Musawi, 2007).

6.3.3.2 Adopting eTechnologies

Both public and private institutions in Oman increasingly rely on information and communication technologies to develop their students' skills and infrastructures (Al-Senaidi at el, 2009). Unlike Libya, versions of learning management systems such as WebCT, Moodle, and e-Portals have been implemented at many educational institutions (Al Musawi, 2010). Sultan Qaboos University (SQU) began to implement eLearning, using WebCT, in 2001. At that stage there were eight online courses and 981 users. By the end of Autumn 2002, 40 courses were offered with 3001 students (Al-Senaidi at el, 2009). Since 2005, Moodle has become a major learning management system in use worldwide and the major system in Oman (Al-Ani, 2012).

Although Omani students had little exposure to WebCT at the beginning of their courses, by the end they were able to appreciate their importance and in particular the ease of access to WebCT from any Internet enabled location at any time. This helped students to better understand and learn course material (Naqvi, 2006).

The results of an investigation of a sample of 283 students from all colleges at SQU about the usage of Moodle found supportive evidence for moving towards a blended learning Moodle environment with student responses showing the effectiveness of

using Moodle on their learning motivation, achievement, collaboration and communication skills (Al-Ani, 2012). In addition, the study showed that blended learning including Moodle helps students to be more self-regulated and self-directed, reducing the number of days and hours spent in the traditional face-to-face learning environment (Al-Ani, 2012). It is worth noting that at UOW, the hours of face-to-face contact were not usually reduced with the introduction of blended learning. In another Omani study, most students preferred a face-to-face mode supported by online digital content for comfortable learning (Naqvi, 2006).

6.3.4 The future of ICT and education in Oman

The Oman Accreditation Council (OAC) is tasked with accrediting institutions and programs through the use of standards, information, reviews and quality improvement processes, and with maintaining the national qualifications framework (Carroll et al., 2009). Four strategic areas in the Quality Plan include: infrastructural policies and frameworks; institutional quality assurance; program quality assurance; quality enhancement and capability development (Carroll et al., 2009). The Council of Higher Education has undertaken many important initiatives in fulfilment of its mandate, including the commission in 2005 of a Strategic Plan for all of Education to the year 2020 (Al Shmeli, 2009).

The Government has developed an eOman Strategy with the Information Technology Authority given responsibility for its implementation (Al-Suqri, 2012). Higher education institutions in Oman increasingly rely on educational and information technologies to develop their students' skills and organizational infrastructures (Al-Musawi, 2007). There are already high rates of Internet penetration, estimated at 64% of the population in late 2010.

A number of international cooperation plans have been undertaken. For example a New Zealand consortium of universities was involved in a feasibility study for the transformation of the Colleges of Education and is currently supplying the curriculum for the four original degree programs. The program has recently been expanded to include Engineering, which will be offered initially at the Sohar College of Applied Sciences (Al Shmeli, 2009). Moreover, through a partnership agreement with Aachen University of Applied Sciences in Germany, the curriculum and academic and technical resources for this program will be state of the art (Al Shmeli,

2009).

eLearning is already being successfully used in SQU via the use WebCT and Moodle and many online courses are already available (Al-Suqri, 2012). Al-Busaidi & Al-Shihi (2012) found that computer anxiety, personal innovativeness, system quality, information quality, management support, incentives policy and training are key factors to instructors' satisfaction with using LMS in blended learning and that staff need support and encouragement by SQU in the use of LMS.

6.3.4.1 Artifact Analysis: Structures at SQU

SQU has nine colleges (faculties) with more than 14,000 undergraduate and close to 1500 postgraduate students (QS, 2014). The colleges of Arts and Social Sciences, Economics and Political Sciences, Education, Law and Nursing offer Bachelors and some Masters degrees but they do not offer PhD studies. Bachelor, Master degrees and PhD studies are offered in the colleges of Agriculture and Marine Sciences, Medicine and Health Sciences, Engineering, and Science (Arabian Campus 2010; Al-Senaidi at el, 2009).

A Bachelor degree at SQU usually lasts for five years. The first year is spent in a foundation program (GFP) studying Science, IT, Mathematics, English language, and study skills. A student's future prospects depend on the efficacy and success of the GFP (Al-Shmeli, 2009). The GFP ostensibly helps students to make the transition from the traditional learning methods practised in the schoolroom to the independent mode of study expected in higher education.

6.3.4.2 Artifact Analysis: Bachelor of Science

The Department of Mathematics and Applied Statistics (DOMAS) is one of the largest departments on campus. It offers programs leading to the Bachelor of Science degree in Mathematics, Statistics (DOMAS, 2013). DOMAS also offers postgraduate degrees in pure mathematics, applied mathematics and statistics. Traditional chalk and talk methods (using whiteboards) remain the dominant method of teaching.

Examination of printed materials from the DOMAS indicates students opting for a Bachelor of Science in Mathematics or Statistics must complete 122 credits with: 6 credits university requirements (UR); 6 points University electives (UE); 3 credit

points college requirements (CR); 43 points college electives (CE), 28 credits prescribed by the Department (DR), and 36 points Major electives. A successful completion of roughly 5 subjects per semester and a minimum cumulative grade point average (CGPA) of 2.0 (from a maximum of 4.0) are required to graduate in a Mathematics/Science degree (refer, Table 6.10). Six-credit undergraduate projects divided between two semesters, worth three credits each are an important part of the mainstream Bachelor of Science programs.

Table 6.10 Mathematics study plan in Oman

Semesters	Subjects code	Subjects title	Credits
Semester 1	MATH2107	Calculus I	4
	STAT1001	Introduction to Statistic	4
	COMP2101	Introduction to computer Sciences	4
	SOCY1001	Oman Contemporary society (UR)	1
	LANC2058	Communication in science	3
Semester 2	MATH2108	Calculus II	3
	MATH2350	Foundations of mathematics	3
	ARAB1001	Arabic	3
	HIST1010 OR ISLM1010	Oman &Islamic Civilization or Islamic Culture (UR)	2
	STAT2102	Introduction to probability	3
Semester 3	MATH2202	Linear algebra I	3
	MATH3110	Calculus III	4
	MATH3302	Ordinary Differential Equations	3
		College Requirements	4
		University Elective (UE)	2
Semester 4	MATH3303	Linear algebra II	3
	MATH3360	Discrete Mathematics	3
	MATH3730	Computer algebra system I	3
	MATH4141	Numerical Analysis	3
		College Elective (CE)	3
Semester 5	MATH4450	Real Analysis I	3
	MATH4453	Abstract Algebra I	3
		3 Subjects of College Electives	9
Semester 6	MATH4452	Introduction to Complex Analysis	3
	MATH4474	Introduction to Partial Differential Equations	3
		3 Subjects of College Electives (CE)	9
Semester 7		Project in mathematics	3
		3 Subjects of College Electives (CE)	9
		2 Subjects of University Electives (UE)	4
Semester 8		Project in mathematics	3
		4 Subjects of College Electives (CE)	12

It is not possible to compare the Omani subjects with either Libya or UOW subjects as subject descriptions, as distinct to subject names, were not available to the researcher. However subject titles are suggestive of commonality with mathematics offered elsewhere, providing some indication of what technology could be used with each subject.

6.3.5 Professional development in SQU

Oman adopts a state-led national approach to human resource development (HDR), with around 75% of Omani nationals employed in State owned sectors, with the Omani 2020 programme initiating HDR strategies, training needs in management and administration, IT, technical skills and financial knowledge (Budhwar, Al-Yahmadi & Debrah, 2002). At SQU there are five centres providing professional development or support for staff: the *Centre for Human Resources and Staff Development*, the *Students Counselling Centre*, the *Language Centre*, the *Centre for Information Systems* and the *Centre for Educational Technology*. In 2001 SQU organised a series of workshops, run annually and intended for faculty staff to:

> *…provide them with information about the university and higher education and learning process; promote their talents for designing learning centred courses; improve their skills for presenting information and implementing instructional strategies; provide them with the support for designing, selecting and utilizing appropriate information and communication technology and instructional media; develop their testing and assessment skills to support student learning; develop their research skills and provide them with information on academic advising , supervision and the University credit system (Al-Musawi, 2008, p.94).*

Recently the Centre for Education Technology (CET) at SQU provided all colleges with access to and support for WebCT campus edition (Naqvi, 2006). CET describe their current, 2014, activities as follows:

> *We are currently venturing into the e-learning domain and at the stage of developing comprehensive training and consultancy packages to enable faculty to develop high quality instruction. (http://www.squ.edu.om/cet/tabid/373/language/en-US/Default.aspx)*

The broad aims of this study were to raise awareness of the importance of technology for improving students' learning outcomes and to create a broader culture of technology use, so as to facilitate the development of a supportive community of practice. The program of workshops developed for Libya was made available to SQU staff, after firstly establishing the nature of similarities and differences between the two locations. Interviews were held with eight staff at the centres of staff development at SQU in order to ascertain the manner in which professional development was undertaken at SQU and issues associated with this.

A survey was used to identify the software that postgraduate students used and the source of their training on this software. Interviews with twenty-nine mathematics

staff were conducted. The first part of this interview included the survey questions asked of postgraduate students to determine the technology and software used by DOMAS staff and the functions performed by that software. A separate survey of mathematics staff (*Improving mathematics education through the use of technology*) was used to identify difficulties facing lecturers wishing to integrate technology into their teaching. The evaluation of the professional development program is based on data collected from 36 participants on the effectiveness of training. Evaluation was also conducted on professional development in the use of software and hardware that can be used to support and improve teaching and learning in mathematics. One participant in the professional development program was selected to provide a case study of an individual lecturer provided with additional support and mentoring in the use of the Tablet in lectures and the production video resources for use with students.

Evaluation can help determine how well training identified and addressed learners' reasons for wanting to gain new knowledge or skills (Bryan at el., 2009). Adult learning principles can be applied during three essential steps in the training process: assessing trainee needs; planning and delivering training; and evaluating the process and impact of training activities (Bryan at el., 2009).

6.3.5.1 Identification of postgraduate students software use

An initial survey was used to identify the technology and software that was used by Omani mathematic postgraduate students (Section 5.6.3.1). In total 10 postgraduates responded. The specialist packages used most frequently was Mathtype (70%) and LaTeX (40%), with the reverse weightings for use by UOW students with LaTeX (87.9%) and Mathtype (42.4%), MATLAB (18.2%). A smaller proportion of the students sampled used statistical software at SQU than UOW possibly reflecting a greater number of Statistics students surveyed at UOW than at SQU (refer, Table 6.11). The use of Microsoft Word and PowerPoint is common in both institutions, with Excel having much higher use at UOW than at SQU. This suggests that an introduction to the use of Excel in mathematics could be useful. Conversely a greater proportion of students at SQU use MATLAB than at UOW.

Table 6.11 Use of mathematics packages by mathematic postgraduate students

Functionality	Software packages	Postgraduate At SQU		Postgraduate At UOW	
		(n=10)	%	(n=33)	%
Mathematics packages	Mathtype	7	70	14	42.4
	MATLAB	6	60	6	18.2
	Mathematica	5	50	-	-
	LaTeX	4	40	29	87.9
	Maple	3	30	15	45.5
Statistical packages	SPSS	3	30	11	33.3
	R	2	20	12	36.4
	SAS	1	10	8	24.2
	MLWIN	1	10	1	3.1
	S	0	0	1	3.1
	STATA	0	0	1	3.1
Microsoft	Word	9	90	29	87.9
	PowerPoint	8	80	27	81.8
	Excel	4	40	24	87.9
	PDF creator	1	10	8	24.2
Other packages	Scientific work place	3	30	-	-
	Beamer	3	30	10	30.3
	Fortran	1	10	-	-
	Moodle	0	0	-	-

Postgraduate students learn to use packages in a variety of ways (refer, Table 6.12). The dominant modes of learning were informal; searching the Internet, self-learning, supervisor assistance and asking a friend whereas at UOW self-learning and previous learning in a subject were the most common methods used.

Table 6.12 Ways to learn to use packages

Themes	Postgraduate At SQU		Postgraduate At UOW	
	(n=10)	%	(n=33)	%
Self learning	10	100	23	69.7
Searching in Internet	8	80	14	42.4
Supervisor	6	60	3	9.1
Asking friend	5	50	9	27.3
As a subject at undergraduate / master degree	4	40	16	48.5
Workshop	2	20	2	6.1
Reading book	2	20	11	33.3
Help manual	1	10	7	21.2
Learning by doing	1	10	9	27.3

6.3.5.2 Interviews: Mathematics staff in DOMAS

Interviews with 29 mathematics staff out of a total of 54 were conducted. The first part of the interview included the survey questions asked of postgraduate students. Interviews were conducted in part prior to the surveys and in part after the workshop and surveys of staff. The interviews, undertaken in English showed that most lecturers interviewed in DOMAS are not of local origin (n=23, 79.3%). The Head of

School is a local. All staff interviewed at SQU use Excel and PDF creator compared to approximately 79% and 70% of staff respectively at UOW. A similar proportion of interviewed staff, 83% at SQU and 79% of staff at UOW were using a Learning Management System (refer, Table 6.13). The major difference in use was in terms of the mathematics software packages with 90% of SQU staff using Mathtype compared to only 14% of staff at UOW. There was little difference in the use of the statistical software packages at the two institutions. No staff were using Camtasia Studio or Tablet PCs to develop resources for eLearning site which were the innovations of interest. Only one member of staff had experience with the creation of video resources.

Table 6.13 Use of mathematics packages by staff

Functionality	Software packages	Staff at SQU		Staff at UOW	
		(n=29)	%	(n=28)	%
Mathematics packages	Mathtype	26	89.6	4	14.3
	LaTeX	24	82.7	27	96.4
	Maple	16	55.1	19	67.9
	MATLAB	16	55.1	6	21.4
	Mathematica	5	17.2	5	17.2
	Gap Algebra program	1	3.4	-	-
	Maxima	1	3.4	-	-
Statistical packages	SPSS	7	24.1	7	25.0
	SAS	6	20.6	6	21.4
	R	6	20.6	9	32.1
	S	3	10.3	3	10.7
	MLWIN	2	6.8	2	7.1
	STATA	1	3.4	3	10.7
Microsoft	Excel	29	100	22	78.6
	PDF creator	29	100	19	70.4
	Word	28	96.5	28	100
	PowerPoint	27	93.1	16	57
Other packages	Moodle /eLearning	24	82.7	22	78.6
	Scientific work place	8	27.5	-	-
	Beamer	7	24.1	15	53.6
	Fortran	4	13.7	2	7.1

Staff learn to use packages in a variety of ways (refer, Table 6.14) and this differs between institutions. The dominant modes of learning were informal: searching the Internet (83%), self-learning (83%) and asking a friend (83%) at SQU. They are also the top three sources of help for mathematics staff at UOW although at UOW while highly engaged in self-learning (93%) staff relied a little less than SQU on searching the Internet (46%) and asking a friend (61%).

Table 6.14 Ways to learn to use packages.

Themes	Staff At SQU		Staff At UOW	
	(n=29)	%	(n=28)	%
Searching the Internet	24	82.7	13	46.4
Self learning	24	82.7	26	92.9
Asking friend	24	82.7	17	60.7
Workshop	6	20.6	6	21.4
As a subject at undergraduate / master degree	4	13.7	2	7.1
Supervisor	2	6.8	-	-
Reading book	0	0	4	14.3
Help manual	0	0	5	17.9
Learning by doing	0	0	8	28.6

The interviews indicated that in earlier years problems teaching mathematics had been identified. In 2004 a lecturer coordinating a basic mathematics subject identified a critical issue with student learning leading to a failure rate of approximately 45%. The possible reasons for this failure rate were language difficulties, different ways of teaching from high school and students having access to few resources. Prior to an eLearning site being available, a textbook was produced containing all exams with solutions. This was printed and given to every student. Learning development opportunities were created in the form of a "drop in centre" for students, which provided help to students when they needed it. Fourteen staff provided help for students. As a consequence, Adel [2] said it was found:

> *The student learning outcome was improved with the failure rate decreasing from 45% to 20% and during those 2 years it was very supportive and the students liked it.*

Unfortunately, the "drop in centre" closed because of a lack of space.

All the lecturers interviewed used textbooks as the primary resource for their teaching. All the lecturers used a traditional method of teaching with a whiteboard.

They argued that the student experience and culture is compatible with this method and that they are comfortable with this type of teaching. Adel suggested,

> *The best thing to improve student learning is to stop them treating [students] as babies. If you force them you are a bad teacher and you have to do everything and they don't do anything independently.*

[2] All names used are pseudonyms to protect the identity of participants, with Arabic names for Arab participants.

That supported by Al-Musawi, (2008, p. 12) who argues that:

> *Culture plays a significant role in certain settings. It seems that teaching and learning skills are context-based and they necessitate the development of culturally adapted approaches to the professional development activities. This does not only emphasise the need for a more indigenous set of policies and programs but also for specially designed materials and software.*

DOMAS has sufficient computer laboratories, computers and licenses for software such as SPSS, MatLab, and Maple. However, staff suggested that such software is not widely used in teaching and that additional workshops need to be run on using software. Amine suggested:

> *We do have resources and we have no one using them because of lack of experience. We need departmental policy to use the computer and implement them in the course.*

Khaled said:

> *People are not using what they have.*

While Mariam and Jay indicated that:

> *They need to use the current technology more efficiently and with proper use.*

Of the many subjects available only one subject, "computer algebra system", offered students an opportunity to learn Maple, MATLAB and LaTeX. Some staff use freely available software, but not extensively, in their teaching. For example, six staff (20.6%) use R in their teaching and research, one staff member used Maxima (http://maxima.sourceforge.net/), which is similar to Maple, while another used the Gap Algebra program. Common proprietary software used included Microsoft Word (n= 28, 96.5%) and Scientific WorkPlace (n=8, 27.5%), which is used to edit and typeset mathematical and scientific text to produce LaTeX-based typeset documents. Staff found Scientific WorkPlace easier to use than the freely available LaTeX package (http://www.mackichan.com/index.html?products/swp.html~mainFrame).

SQU currently has Moodle Versions 1 and 2. As these employ a very simple editor for embedding mathematical equations, teachers have to find alternative ways to incorporate complex mathematical equations. Staff will have many options to embed or combine complex mathematical equations when the newer version of Moodle is implemented.

Twenty four staff (82.8%) used Moodle. It was used primarily as a storage facility for documents such as previous exams papers, tutorial solutions sheets and subject outlines. Most lecturers scan a hard copy of tutorial notes, exam papers and solutions and upload to them Moodle. Staff did not use other Moodle facilities such as selective release, the calendar, online quizzes or the discussion forum. The lack of awareness as to these facilities or how to use them within Moodle might be the reason staff had little motivation to use eLearning. As one staff member said "if there was a unit in the department giving the support to improve Moodle that would be very helpful". Brack at el (2005) suggests there is more to the reluctance of using eLearning site than technical capability:

> *Exploiting eLearning opportunities presents a challenge for many teaching academics. It may involve a reversal in the way they think about their teaching, to place the focus on learning rather than teaching, and on learner activity rather than content. In addition, it may involve rethinking in visual terms material that they have previously engaged with only orally or textually (p.52).*

Academic staff prefer to use email to contact their students or to speak face-to-face in class to them (100% n= 29). This is in accord with results from a study on students in the College of Science at SQU (Al-Khanjari at el, 2011), which includes DOMAS, which showed that most learners communicate using email for both individual and course work.

Staff indicated developments in the use of technology that they would like to see:

- Replacement of school meetings.
- Establishment of a website.
- Two staff wished to extend the use of communication facilities even further, suggesting the use of social networks to contact staff with ideas, rather than having to sit through two and half hours long meetings. Meetings could then be short and just for approval.
- Four staff members highlighted the need to integrate technology into the curriculum.

To help integrate technology into the curriculum, more time and additional training resources illustrating how to integrate technology and provide motivation, are needed. As Khaled indicated:

> *Proper training for staff to feel comfortable to use a computer and use math packages. Some staff are not happy and will argue against.*

Max, Jett and Edie requested,

> *... More workshops on how to use programs and try to convince academic staff to use it*

A stumbling block regarding the integration of technology is the use of multiple lecturers in a subject when not all of them are conversant with the use of technology. This results in none of the lecturers using the technology. The staff perceive that technology is available but that it is difficult to convince staff to use it. Edie commented,

> *It is hard to convince them to use technology. They always say "no time to use it" and maybe they don't trust technology. For example the model exists but few use it. The use of Tablets it is really useful and for statistics R is free so why do people not use it when you have the opportunity to give it to students to use any program they like? But maybe some people learn something else.*

Edward expressed the need to embed technology in the curriculum and to enforce such a policy:

> *People have different opinions about technology. We have six laboratories and computers without software but they have Maple and Mathlab licenses but it is not embedded in the curriculum, and the syllabus outcomes do not mention any use of technology. When we have a team one of them will say" no" and no one will use it. For example, the team of the subject responsible for say elementary calculus: if someone wants to embed software use and others do not, no one accepts it because it is not in writing or mentioned within the syllabus. It should be enforced for staff by being written in the syllabus to use the component of technology*

To motivate staff to embed technology into their teaching they noted the need for departmental deliberation and planning to integrate technology into the curriculum. As Adel indicated:

> *If DOMAS is willing to do this there should be a policy for eLearning components and a policy for use software packages like Maple. If there is no policy some might do it, others may not, if it is not written in the requirements.*

Crystal recognized the need to require the integration of technology through formal means:

> *We do have laboratory computers and software licences, but there is no will to use it, we need it written in the course syllabus, formally that the course contains technology components.*

Carl was prepared to have staff "forced" to implement the technology they knew:

> *Try to force to academic staff to try whatever they know in their courses.*

Lecturers have different opinions about the use of technology, indeed there are some

staff who believe that mathematics is best learned without technology:

> *Two categories: some people like to use old fashioned techniques because they think the student will rely on technology and not think deeply. Other people who like teaching with technology said it helps students to understand more mathematics. We have facilities but need to use them.*

A pure mathematician, Aston, said:

> *In learning mathematics you need to see development in front of you.*

Sixty-eight percent of interviewed staff (n=20) believe that technology can enhance student learning and could improve the efficiency of their own performance in research and teaching. Technology could also save time when dealing with students and could provide learning experiences, opportunity and tools that would otherwise be unavailable to both student and staff. Nevertheless, the levels of engagement in ICT by academic staff seem to depend upon both their attitudes and their level of confidence in using the technology. Staff members who have little confidence in using computers try to avoid using them in their teaching.

Technical support is also required. Carl, Crystal and Max remarked:

> *We need more equipment or technology and more technicians and policy to make it a requirement.*

Seventy-two per cent of staff (n=21) indicated a need for technical support to solve technical problems. There is also a need to liberate time for training staff currently lacking time to learn new technologies. These conclusions are similar in part to previous research conducted at SQU across four departments at the College of Applied Sciences by Al-Senaidi et al (2009). Al-Senaidi et al indicated that the barriers to adopting ICT at SQU include a lack of equipment, a lack of institutional support, disbelief in the benefits of ICT, a lack of confidence, a lack of time, a need to provide more institutional support, technical training, and personal time for faculty members to learn and upgrade their knowledge and skills in educational technologies. Many staff in this study indicated that although technology was available, that policy was required to “force” staff to use it. Brack et al (2005) have argued:

> *Many teaching academics are driven by research as this is directly related to academic promotion and to government funding. They often lack formal professional training in teaching in higher education, and facing increasing workloads, lack time to invest in teaching innovation (p. 53).*

The review by Mumtaz (2000) supports the result of the SQU study which reveals a number of factors that influence teachers' decisions to use ICT in the classroom. These factors include: access to resources, quality of software and hardware, ease of use, incentives to change, support and collegiality in their school, school and national polices, commitment to professional learning and background in formal computer training. The review also highlights the role of pedagogy and suggests that teachers' beliefs about teaching and learning with ICT are central to integration. In accord with (Mumtaz, 2000) it is suggested that successful implementation of ICT needs to address three interlocking frameworks for change: the teacher, the school and policy makers.

6.3.5.3 Survey: Improving mathematics education through technology

To ensure targeting of staff development, the survey *Improving mathematics education through the use of technology* and interviews (Section 6.3.7.2) were used to identify which software and resources were already used, their needs, and the difficulties faced in integrating technology. This information provided the background context to ensure that professional development was orientated in a manner that suited staff. Secondly the survey was used to identify difficulties facing lecturers wishing to integrate technology into their teaching.

Twenty-one of the mathematics department staff members, 85.7% of males (n=18) and 14.3% of females (n=3) participated in the survey, with some substantial overlap with those interviewed. It is notable in the summary (refer, Table 6.15) that over 62% the participants were senior members of staff, with 85% of the participants in the age range 41–60 years.

Table 6.15 Staff classification and age

	Frequency	**Percentage (%)**
Staff classification		
Professor	2	9.5
Associate Professor	11	52.4
Assistant Professor	5	23.8
Demonstrator	2	9.5
Age (years)		
61-70	3	14.3
51-60	8	38.1
41-50	7	33.3
31-40	1	4.8
24-30	2	9.5

Staff considered themselves to have moderate to high levels of experience in using technology, with no staff considering themselves to be inexperienced in computer and Internet use (refer, Table 6.16).

Table 6.16 Staff experience using technology, computers and the Internet.

As a technology user, I classify myself as	Frequency	Percentage (%)
Beginner w/support	2	9.5
Confident on my own	14	66.7
Capable of teaching others	5	23.8
Rating of computer experience		
Moderate experience	10	47.6
Experienced	11	52.4
Inexperienced	0	0
Rating of Internet experience		
Moderate experience	12	57.1
Experienced	9	42.9
Inexperienced	0	0

There is a high level of staff usage of the Internet with 95% of staff being daily users. The level of use in teaching is considerably lower (refer, Table 6.17).

Table 6.17 Staff usage of the Internet and computer in teaching mathematics

How often do you use the Internet at Home /work?	Frequency	Percentage (%)
Daily	20	95.2
Less than once a month	1	4.8
How often do you use the Internet for your teaching?		
Daily	4	19
Once or twice a week	9	42.9
Once or twice a month	2	9.5
Less than once a month	6	28.6
How often do you use the computers in teaching mathematics?		
Daily	2	9.5
Once or twice a week	5	23.8
Once or twice a month	3	14.3
Less than once a month	9	42.9

According to the survey results, the dominant mode with all using email to contact students and staff was email, with Skype unavailable and Facebook rarely used (refer, Table 6.18).

Table 6.18 Contacting students and staff

Used to contact your student	Frequency	(%)
email	21	100
In class	16	76.2
Facebook/similar	1	4.8
Skype/similar	0	0
Used to contact your colleagues		
Email	21	100
Facebook/similar	1	4.8
Skype/similar	0	0

All lecturers identified the textbook as a key resource, whereas only one lecturer used video resources (refer, Table 6.19). One of the foci of the professional development was the use of videos as a form of mathematics learning support.

Table 6.19 Resources used by lecturers

What sort of resources do you use?	Frequency	Percentage (%)
Text book	21	100
Books	15	71.4
Assignments	15	71.4
Worked solutions for in-class tests, midterms and exams	14	66.7
Internet	13	61.9
Subject outline	11	52.4
Consultation with lecturer	9	42.9
Tutor in Practical classes	5	23.8
Opportunity to undertake re-tests	5	23.8
Films/video	1	4.8

The most frequent use of technology was for administrative purposes, such as typing letters and documents (n=19, 90.4%). In the classroom there is a more conservative use. For example, only 52.3% of staff (n=11) used it for the creation of instructional material and only 14.3% used it in classroom presentations (n=3) (refer, Table 6.20).

Table 6.20 Purposes for the use of technology

Frequency and type of use:	Don't use or Occasional use*		Moderate or Extensive Use **	
	Frequency	%	Frequency	%
Type letters and other documents	1	4.8	19	90.4
Administrative record keeping	3	14.3	18	85.7
Student Grades, Students details, etc	2	9.5	18	85.7
Word processors	6	28.6	14	66.6
Spreadsheets	7	33.3	12	57.1
Create instructional material	10	47.7	11	52.3
Databases	11	52.4	7	33.3
PowerPoint/CDs/DVDs	14	66.7	5	23.8
Classroom presentations	17	81.0	3	14.3

* Occasional 1 hour or less per week,
** Moderate or extensive (>2 hours per week)

Focusing specifically on Internet usage, the most frequent use relates to administrative record keeping (n=16, 76.2%). This was followed by searching for information on topics of personal interest (n=15, 71.4%) and retrieving research and best practices for teaching and learning (n=15, 71.5%). Less frequent was the use of the Internet for retrieving Moodle lesson plans (n=5, 23.8%). Other purposes for the Internet used are summarized in Table 6.21.

Table 6.21 Frequency and type of use of the Internet

Frequency and type of use the Internet	Don't use or occcasional use *		Moderate or extensive use **	
	Frequency	%	Frequency	%
Administrative record keeping	5	23.8	16	76.2
Search for information on topics of personal interest	6	28.6	15	71.5
Retrieve research & best practices for teaching/learning	6	28.6	15	71.5
Communicate with family/friends	7	33.3	14	66.6
Search for information and content for lessons	7	33.3	14	66.7
Communicate with other teachers	8	38.1	13	61.9
Communicate with students on school related matters	11	52.4	10	47.6
Retrieve Model Lesson Plans	14	66.7	5	23.8
Purchase items online	19	90.5	-	-

* Occasional 1 hour or less per week, ** Moderate or extensive (>2 hours per week)

When the staff were asked about the integration of technology into the classroom, they considered that technical support was a problem (n=15, 71.5%). They also indicated they would like to attend workshops which showed how to integrate computers into the curriculum (n=14, 61.7%). Two members of staff declared that mathematics is best learned without technology (9.5%). Table 6.22 provides more detail.

Table 6.22 Attitudes toward staff development in technology use

What, if anything, do you need to make technology an integral part of your department or classroom's curricular activities?	**Strongly agree and agree**	
	Frequency	**%**
Technical support in the use of computers from someone who could be considered an "expert" is beneficial for integrating the computer into my classroom practice	15	71.5
Attend workshops which shows how to integrate computers as into the curriculum	14	66.7
Using a "trial and error" approach has increased my knowledge on use of computers	14	66.7
Websites on the Internet about designing teaching strategies are helpful to me for integrating the computer into my classroom practice	14	66.7
Attend conferences/seminars designed to increase my knowledge on use of computers if my district would pay for it	12	57.1
Observing colleagues to learn about computer integration strategies would be helpful for me so as to integrate computers into my classroom practice	12	57.1
Prompt technical assistance would facilitate my efforts to learn to integrate the computer into my classroom practice	12	57.1
Periodicals/professional literature related to computer use has increased my knowledge on use of computers	8	38.1
Enrol in computer training classes designed to increase my knowledge on use of computers if my district would pay for it	8	38
Pay my own expenses to attend formal training activities designed to increase my knowledge on use of computers	2	9.6
I believe that mathematics is best learned without technology	2	9.5

Sixty two per cent of staff (n=13) considered that the people in their community view technology as either 'important but not a priority' with 28.6% considering it to be 'very important' (n=6) with only one declaring it to be unnecessary (4.8%), and one indicating that they did not like it (4.8%).

The dominant issues (refer, Table 6.23) in relation to integrating technology into the classroom are related to time. For example, staff needed prompt technical support (n=16, 75.2%) and time to learn to use software for teaching mathematics (n=10, 74.6%).

Table 6.23 Time as a resource needed to integrate technology

To make technology an integral part of your department or classroom's curricular activities	Strongly agree / agree	
	Frequency	%
I need prompt technical support to keep the computers working	16	75.2
I need more time to learn to use software with teaching mathematics	10	74.6
I need the administration to provide time for integrating technology into the classroom	12	57.1
I need more time to change the curriculum to better incorporate the technology	11	52.4
I need more time to learn to use the Internet.	4	19.1

Staff also indicated that they needed resources that demonstrated how to integrate technology into the curriculum (n=13, 61.9%) and the opportunity to work with experienced colleagues (n=13, 61.9%) (refer, Table 6.24).

Table 6.24 Resources needed to integrate technology

To make technology an integral part of your department or classroom's curricular activities	Strongly agree / agree	
	Frequency	%
I need more resources that illustrate how to integrate technology into the curriculum	13	61.9
I need the administration to provide resources for integrating technology into the classroom.	13	61.9
I need more opportunities to work with colleagues to become more proficient using technology-enhanced curriculum units	13	61.9
I need more examples in the use of technology in my content area	11	52.4
I lack the knowledge of ways to integrate ICT to enhance the curriculum	7	33.3

Forty-three per cent (n= 9) of staff wanted the integration of technology to be led by university planning (refer, Table 6.25).

Table 6.25 Administrative planning needed to integrate technology

To make technology an integral part of your department or classroom's curricular activities	Strongly agree / agree	
	Frequency	%
A university technology plan, in which skills needed to be achieved are clearly spelled out, would help me to integrate technology.	9	42.8
A district technology plan outlining steps for technology integration would help me to integrate technology	9	42.9
I need the administration to provide staff development activities in technology to persuade me to integrate technology.	8	38.1

When asked about their need to make technology an integral part of classroom's curricular activities, 52.4% (n=11) of staff considered that they needed more training in strategies that integrate technology whilst 42.8% (n=8) of staff needed more training with technology. Nineteen per cent (n=4) of staff found it difficult to integrate and use different ICT tools in a single lesson (refer, Table 6.26).

Table 6.26 Needs for more training

To make technology an integral part of your department or classroom curricular activities	Strongly agree / agree	
	Frequency	%
I need more training in strategies that integrate technology.	11	52.4
I need more training with technology	9	42.8
I need to be able to try out technology-enhanced curriculum units in my classroom before I am comfortable with them	10	47.6
I lack confidence with regards to integrating technology into the classroom	2	9.5
I find it difficult to integrate and use different ICT tools in a single lesson	4	19.1

To facilitate staff integrating technology into their mathematics teaching all staff drew attention to 'students lack access to the necessary classroom educational technology materials'. Fifty two per cent (n=11) suggested that reliable access to the Internet would facilitate their integration of technology into the classroom (refer, Table 6.27).

Table 6.27 Facilitators of technology use

To make technology an integral part of your department or classroom's curricular activities	Strongly agree / agree	
	Frequency	%
I need access to the Internet that is reliable	11	52.4
I need more current software that is curricular-based.	9	42.9
I need access to more computers for my students	7	33.3
Students lack access to the necessary classroom educational technology materials	26	28.6
If I had enough computers in my classroom for each student, I would create more learning activities using the computer	5	23.8
I need good reasons why I should incorporate technology into the classroom	7	33.3
I lack personal access technology during lesson preparation	1	4.8

The uptake of technology in teaching by DOMAS staff is likely to be related to the perceived benefits. At DOMAS 76% (n=16) of staff believe that technology can provide learning experiences, opportunities, and tools that would otherwise be unavailable to students. Sixty-seven per cent (n=14) of staff considered that technology enhanced classrooms and their teaching. Ten per cent (n=2) of staff did not believe that technology helped in learning mathematics (refer, Table 6.28).

Table 6.28 Benefits of technology for teaching and learning

Perceived benefits of technology,	Strongly agree / agree	
	Frequency	%
Technology can provide learning experiences, opportunities, and tools that would otherwise be unavailable to them	16	76.2
Technology Enhanced Classrooms enhance your teaching	14	66.7
Technology could improve the student learning mathematics	14	66.6
Technology could improve the efficiency of your performance in your research and teaching	12	57.1
Technology could enhance the effectiveness/efficiency of students learning mathematics in the university	12	57.1
Technology could provide a number of alternative medium for learning from which mathematics	11	52.4
Technology can increase understanding for mathematics	10	47.6
Technology could make learning more convenient	9	42.9
Technology could save time in dealing with students	9	42.8
Technology doesn't help learning mathematics	2	9.6

6.3.5.4 Evaluation of the professional development program

The evaluation of the professional development program is based on data collected from 36 participants during the Fall 2012 academic year following the end of the *Raising Awareness* workshops. Eighty-six per cent of lecturers provided an overall positive response to the training with 91% reporting they had been given ideas about how to integrate technology into the classroom, 83% indicating that the workshop held their interest and 75% reporting they were given ideas about the development of resources for teaching and learning (refer, Table 6.29).

Table 6.29 Staff ratings of workshop outcomes

Questions	Agree / Strongly Agree	
	N =36	%
1. Overall, positive rating of the course	31	86.2%
2. Interest held	30	83.3 %
3. Participants gained ideas about how to		
• Integrate Tablet PC into the teaching process	33	91.6%
• Produce video resources by using Camtasia software.	27	75.0%
• Combining learning resources using Learning designs	24	66.6%
• Use Evidence based evaluation to guide change	20	55.2%
• Use Summertime Math DVD / or similar	14	38.9%

A large number of respondents noted that they would like to try using a Tablet PC in their teaching. However, there was only time for one staff member, Samira, to trial the use of the Tablet in class over a period of a week. The selected lecturer for the case study integrated the Tablet PC technology into her teaching both in lectures and developing resources and further found that the Tablet technology was more easily integrated with the learning activities than the use of a whiteboard. Samira stated:

> *I like my experience about use of tablet. For one week with students in my calculus 1 subject and for two lecturing I like the use of Tablet PC prepared notes in different style and use of programs like Maple or Mathlab. I use most of the features in the pdf Annotator and I like it and with more time I will be more professional. There is benefit for both student and instructor: Saving time for lecturers and if you give them lecture with partially incomplete note they not spend time to write everything and use the time in discussion.*

This ease of integration into the classroom experienced by Samira is also echoed by the comment of the Head of SMAS at UOW about the impact of Tablet technology:

> *I consider the shift from computer presentations to the use of tablets to be at least as significant as the shift from overheads to computer presentations. (Porter and Denny, 2011, p. 36).*

Samira recorded seven video resources on the topic of limits. These included: continuous functions, limits with worked examples, squeeze theory and the Newton method. The production of these involved a range of techniques (refer, Figure 6.4 and Figure 6.5).

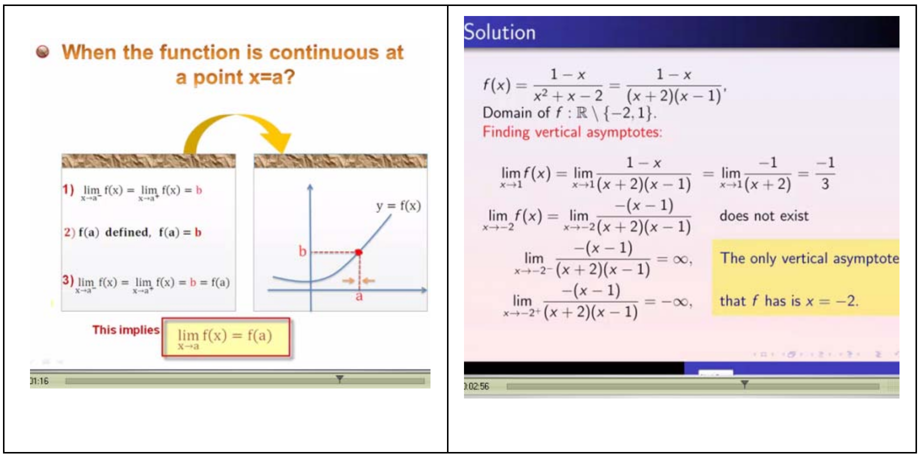


Figure 6.4 Theory snippets and worked examples.

One of these videos involved the sophisticated inclusion of a graphic animation of Newton's method into the video (refer, Figure 6.5).

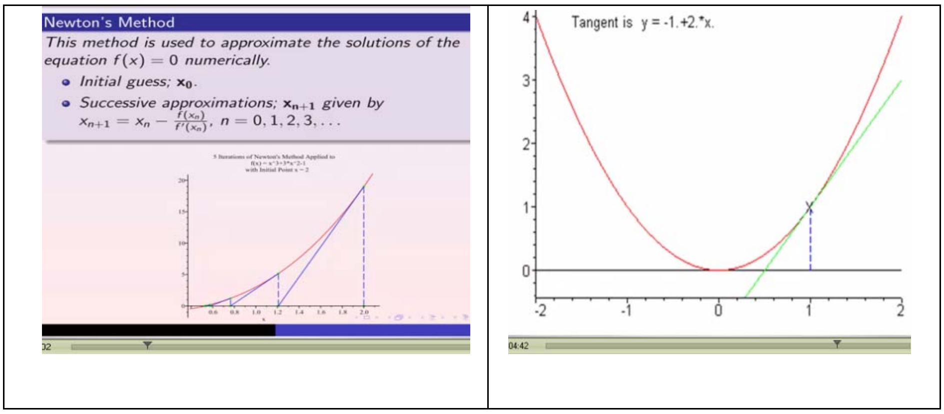


Figure 6.5 Embedded graphic animation of Newton's method

This lecturer, Samira, has continued to work with members of *The Centre of Educational Technology* to create additional video resources covering all calculus chapters. In Summer 2012 she created a new Moodle page for the course Math 2107 using the new version of Moodle, Moodle 2.2. She also developed e-resources with the aid and support of the *Centre of Educational Technology* and *Teaching and Learning Department*. In addition to videos resources, Samira created online quizzes and a discussion forum. In terms of sustained outcomes and changes to mathematics education she is planning in Spring 2013 to provide student access to the new Moodle page, which will have resources uploaded in to it.

The combination of the workshops with individual coaching has engaged staff to think about ways to improve students' learning leading to positive outcomes. While the training program was considered a success by participants on an individual level, there are issues with regard to desires to "move the institution" towards better

practices. Many members of staff told the researcher that their reason for not attending the training offered was a lack of time, even though they were given the opportunity to choose a time slot that suited them. Others considered that it is not effective to engage in training when there are no Tablet PC s or Camtasia Studio software available in the department for them to use after training. With only four Tablet PCs, and a limit of four persons per session it was time-intensive to train a large number of staff, although this policy ensured that participants received individual attention. The wider audience of DOMAS was not aware that the case study training extended to developing a teaching grant application for the provision of resources.

Analysis of the evaluation of the professional development raised issues about the environment in which staff worked, more so than the professional development program itself. While many of those who responded indicated an interest in additional training in creating resources, 28% of staff (n=8) indicated the need for more time to practice and three staff member recognised that they needed patience to learn. Three of the staff suggested that the presenter should also have and use a Tablet PC in the workshop. In order to integrate technology into mathematics education respondents considered the University needs to cover the costs for the school providing software, updates and technical staff. Currently Tablet technology is not available and technical support is limited. Thus, an action plan to the implement and integrate Tablet technology into teaching mathematics at SQU needs to be developed and perhaps a plan to use open access resources. Staff wanted to apply their professional development in a variety of ways (refer, Table 6.30).

Table 6.30 Applying professional development and future needs.

One thing from workshop they could apply to their academic work	What additional training if any would be helpful they responded
• Five staff wished to record summaries of units, lectures or tutorials using Camtasia Studio. • Using it in the class room to introduce this technology, • Tablet PC is the best for teaching, Very good program, • Eleven of staff would like to use all features in the class, • One indicated “I would like to use Camtasia studio to produce further videos”.	• Two of staff wanted training in the of use PowerPoint to record videos, • Two of staff suggested more training would be helpful for continuous use of the Tablet • One staff wanted training to prepare a complete topic. “I hope to practice the other software such as LaTeX and Mathematica, Maple through the tablet,” • Another wanted to “use of the Tablet in a course to enhance practice”.

6.3.5.5 Student evaluation of the use of the Tablet PC in lectures

The first mathematics course for students who will major in mathematics or statistics is Calculus I. Many majors in the College of Science require a pass in Calculus I with a specified grade (C or higher). This subject is compulsory for students in colleges including Agriculture and Marine Sciences and Engineering. Many second year students take this subject after they finish the foundation program. Other students are either repeating the course (3rd, 4th, 5th year students) or passing the exit test of the foundation program (first year students).

Calculus I contains four chapters: limits, derivatives, applications of derivatives and integration. During the Autumn term 2012 there were 593 students enrolled in this subject. These were split into twenty groups of students, each with a different lecturer. The number of students in each group ranged from forty-three to forty-five.

Samira trialled the use of the Tablet PC in two lectures in the Autumn term of 2012, The topics covered in the lecturers were linear approximation using tangent lines, Newton's method for finding the solutions of the equation f(x) =0 and L'Hôpital's rule for the evaluation of limits. A survey was distributed to students following the end of the second lecture to examine how receptive they were to the technology.

Eighty-six per cent of respondents (n=31) were male and fourteen per cent were females (n=5). The majority of students had a positive response, finding the teacher well prepared both when using the whiteboard (86.1%, n=31), her usual medium for teaching, and the newly introduced Tablet PC (83.3%, n=30).

Students had a positive response for the use of Tablet PC which had the top ranking as an effective medium for teaching (86.1%, n=31) and it was found to support and enhance learning by (77.8%, n=28) of students (refer, Table 6.31).

Table 6.31 Usefulness of the Tablet PC in learning mathematics.

The lecturer's use of the Tablet PC	N	% Agree & Strongly Agree
a. Tablet was a really effective medium for teaching	31	86.1
b. Supported or enhanced my learning	28	77.8
c. Helped me learn the subject content more easily	25	69.4
d. Greatly improved visual or PowerPoint presentations.	25	69.4
e. It aided learning as it clearly showed how to reach solutions	24	66.7
f. Helped me actively engage with learning in the class	22	61.1

The best features of the Tablet PC noted in student feedback (refer, Table 6.32) were the ability to use other types of media in addition to text and drawings (88.9%, n=32), being able to explain concepts using a step by step method (83.3%, n=30), allowing an appropriate amount of material to be presented for the time available (80.6%n=29) and the ability to use editing features to emphasize points (72.2%, n=26).

Table 6.32 Usefulness of the Tablet PC features in learning mathematics.

The Tablet's best features are:	N	% Agree & Strongly agree
a. Ability to use other types of media besides text and drawings	32	88.9
b. Being able to explain concepts using a Step by Step method	30	83.3
c. Allowing an appropriate amount of material to be presented for the time available	29	80.6
d. Editing features and emphasis by using it to support and emphasise points	26	72.2
e. Provision of Tablet drawings and notes available after lecture	25	69.4
f. Being able to pre-draw graphs before the lecture so they can be filled in the lecture	24	66.7
g. Incorporating the use of Maple into the lecture was useful	19	52.8
h. Can incorporate the use of other packages	13	36.1

The highest regarded features of the Tablet PC (refer, Table 6.33) were the use of colours and other special writing features for notes (83.3%, n=30), the ability of the lecturer to write out working and solutions to in-class questions (80.6%, n=29) and the ability to highlight parts of the lecture material whilst still facing the class (80.6%, n=29).

Table 6.33 Ranking of the usefulness of the lecturer's use of the Tablet PC

Regarding the lecturer's use of the Tablet PC specifically	N	% Agree & Strongly Agree
a. The use of colours and other special writing features for notes is helpful	30	83.3
b. The lecturer writing out working and solutions to in-class questions, or highlight parts of the lecture material, whilst still facing the class, has been helpful	29	80.6
c. The use of projected notes with inking capabilities has been helpful	27	75
d. Saves you time	25	69.4
e. Writing type on the projected image increased my engagement with the presentation	23	63.9
f. Use of Tablet makes it easy to learn	23	63.9
g. Allows for a more comfortable interaction between the lecturer and the class	22	61.1
h. The presentation is an integral part of the course	20	55.6

The focus of the survey was to identify possible ways to improve mathematics learning through the use of technology. The feedback received from students

regarding the use of Tablet PC (refer, Table 6.34) showed a mixed response, perhaps expected given the new implementation by a recently trained lecturer. In some instances there was a preference for the Tablet PC along with suggestions for further improvement. For other students the Tablet PC was not preferred.

Table 6.34 Student comments regarding the use of the Tablet PC in lectures.

Preference for tablet
- Use Tablet PC in all subjects (4)
- Your way (the Tablet) is better for all students
- New techniques motivate students to work hard and to get good grades
- The notes are better than usual writing in notebook: it's more readable, ordered and understandable
- The structure of the materials and the way it is presented was good

Suggested improvements in use of the Tablet
- If the lecturer gives the students the prepared lecture, every lecture by sending the PDF sheet which is solved in the class to our email rather than writing during the class, it would be helpful to use and may be better to focus more when she uses the project to learn and that would save time (2)
- Have explanations written so they can be reviewed at home for more revision and clarification
- It is good but needs more shape and more colours

Difficulties
- The whiteboard is the best method to use and explain math subject (5)
- Delivering was too fast
- It's a good way but it's hard to follow up if you want to take notes or whatever
- The body language is very important, sometimes the lecturer forgets the students as she focused on the technology
- It is not good method to teach using the Tablet

The lecturer liked the use of the Tablet PC and prepared lectures notes in a different style, but the style was not 'tweaked' to the needs of the students. For example, some students said that "delivery was too fast" and given that the lecturer sat to deliver lectures that "the body language is important".

The lecturer, after professional development, extended her teaching style to use programs such as Maple and MATLAB in lectures. The lecturer used many features of the PDF Annotator software and with more time will become more proficient in its use. By use of the Tablet, she provided notes with gaps for worked examples. Students were then given time in the lectures to attempt the examples before they were worked live by the lecturer using Tablet technology. Updated notes were also made available for students. This method differs from other "gaps in lecture" approaches; see for example Aminifar (2007) who identified that some gaps left in lectures were to allow the completion of worked examples, rather than gaps in theory. With the approach adopted, Samira found that students spent less time writing and that this additional time was used to attempt examples and engage in

discussion.

Samira noted that, in addition to developing expertise in using the Tablet, the next step to be undertaken was to develop and add more video resources and online quizzes to Moodle. Follow up revealed that she created additional video resources covering all calculus chapters. In terms of embedding the professional development more widely Samira indicated willingness to train colleagues.

6.3.5.6 Interviews with Center of Staff Development (CSD)

The Center of Staff Development (CSD) at SQU organizes professional development of staff in order to achieve the University's strategic plans. The CSD shares and develops good practice within SQU (http://www.squ.edu.om/human-resources/tabid/1985/Default.aspx). The CSD consists of several departments: Coordination & Follow-Up, Career Development & Planning, Training & Career Awareness, scholars Affairs, Scholarships & Grants. The *Department of Training and Career Awareness* deals with staff development in SQU (http://www.squ.edu.om/tabid/4131/language/en-US/Default.aspx).

6.3.5.6.1 Professional development program

Interviews revealed that the staff development process begins by analyzing training needs. The CSD circulates a survey at the end of each year to CSD staff and to general and academic staff throughout SQU. Staff make suggestions about their training needs. The CSD studies proposals for professional development of their staff at the beginning of the year. Based on training needs, staff may attend training courses either within or outside the university. Programs are evaluated and selected based on their quality and the trainer profile. The annual training programs runs twice a year, in January and September. Where possible programs are run locally, otherwise staff members are sent abroad for their training. However, overseas training is very expensive. There are some deficiencies with the professional development program, in particular poor access to some programs and to technology. Training is delivered by many providers, working either inside or outside the University to improve the skills of employees. As Adam noted:

> *Sometimes it is not always possible to send trainers abroad because of financial restraints. Some of the well-known trainers are very expensive; however, they choose to invite sometimes well-known trainers.*

The CSD conducts approximately twenty-five training programs, sometimes with tailor-made programs for a college, department or library. As at UOW the staff are diverse and CSD tries to provide professional development for all categories of staff ranging from top managers through to technicians, including academic staff and even providing training for bus drivers. The CSD training program involves updating staff about technological changes in order to enable them to adapt to the needs of the University's objectives and goals. It provides training program such as English and public speaking for secretaries and messengers who deliver mail; it provides creative learning strategies for lecturers with a focus on the classroom and covers creative thinking and situational leadership for leaders. CSD also conducts first aid programs and provides occupational health and safety programs for those who work in the colleges and laboratories.

6.3.5.6.2 Challenges

Job descriptions at SQU indicate competencies required for employees. However, as Adam noted:

> *The department does not have the basic fundamentals that they need for particular standards for each position and for the person who is occupying that position.*

If an employee's competency and qualifications are not sufficient for their position, the department can work on filling the gap between the actual and required competency. Adam explained:

> *We can't even establish another department for estimating or evaluating the training investment... we can't actually evaluate the training.*

6.3.5.7 Interviews with Center of Educational Technology (CET)

6.3.5.7.1 Aims

The aim of the CET is to improve teaching and learning by providing the latest technologies in teaching and encouraging the adaption of the best instructional practices. The CET carries out instructional development activities by producing instructional learning materials and providing media services (http://www.squ.edu.om/cet/tabid/373/language/en-US/Default.aspx). It also offers comprehensive training and consultancy packages to enable faculty to develop high quality instruction through eLearning.

6.3.5.7.2 Services

It provides a variety of services through two main departments: 1) instructional development provides the university academic staff with workshops, seminars and advice on designing effective instructional materials; and, 2) the multimedia department uses high end equipment and software, such as 3D workstations, audio and video encoders, to produce educational materials (http://www.squ.edu.om/cet/tabid/10981/language/en-US/Default.aspx) .

6.3.5.7.3 The important of the technology

Interviews with three staff who attended the workshop and one who did not attend revealed the importance placed upon technology as an effective tool to improve student learning and as a communication tool both between student and peers and between student and lecturers. Ramzi noted:

> *Technology is useful and would also be effective if teachers would integrate it in their teaching process.*

Aden said,

> *For the teachers I think Tablet is a very good media or communication tool to impart to the students for the teachers what they want to teach. Especially for tutoring something like using any software, so visually it can be represented well it's very useful.*

The CET department provides professional development activities such as how to use tools in Moodle to improve and support the teaching process, and how to enhance the use of education technology. The CET staff consider it important for academics to know how to use student feedback

6.3.5.7.4 The professional development approach

The department uses different strategies when undertaking staff development across the University. Each semester the department communicates with academic staff and workshops, depending upon faculty needs, are offered on an approved subject. CET staff members together with a chosen facilitator meet to support groups of up to thirty faculty staff, followed by face-to-face sessions if required.

Meeting with individuals offers the opportunity for CET staff to provide a confidential learner centred approach. Indeed, both face-to-face and group-work are considered important to identifying teaching and learning challenges faced by lecturers in designing their courses. Alaina explained:

The one-on-one is so important because then it will be providing more of the structure that they need. Both are important because the other thing that is really good in the workshops is getting the teachers to say what they have been doing. I think you always have to have in mind where the teachers are at in their thinking and try to get them to be able to express what teaching and learning challenges they have and to find out where they want to go with it and then also try to get them to be aware of where their students are and then design a course according to their needs.

The optimum time to run workshops is during the semester breaks as the lecturers are then free from teaching. This was supported by several lecturers and Faris noted:

They can run three hour workshops or six hour workshops in the semester break and then do one-on-one during the teacher's semester.

Lecturers need support and scaffolding to design their subjects. As teachers apply the skills they learn from their professional development, their students are able to develop more of the critical skills that they require for the workplace, such as being more technologically capable.

Two members of the CET staff commented on staff working in the multimedia department having attended three or four overseas workshops in Malaysia, Bahrain and Dubai to develop their skills. The courses were perceived to be very expensive, although staff members who work in the multimedia department sometimes have very specific learning requirements such as animation. The principles of design for animation involve producing multimedia elements with the software and integrating these with other educational materials. The educational background of the designer supports them in the preparation of multimedia environments used to support student understanding. As Faris noted:

In addition, the education background gives knowledge about how to prepare the content, how to put the aims and goals, how to recognise the content, how to produce it, how to finalise it and how to present it in a good way and how to use the multimedia.

Ramzi gave an example of how interaction with academics is part of a project and its requirements:

For example, The College of Medicine is requiring animation of the human body and they make the animations and images. So to make it [the animations and images] we have to read how it works. So it depends on the project, having to read and watch some videos and then make it real. It's a lot of work but it is interesting and it takes a long time - four months - but it gives new knowledge and new information.

Staff, who work for designers of multimedia, wish to share knowledge with other experts inside and outside of the country. It is considered important to share between experts in the field. As Ramzi said:

> *Doing private projects outside the job hours; it gives us a good opportunity to develop skills. They have their own knowledge and their own experience. The need is to share knowledge between experts or do work on some projects and solve problems.*

6.3.5.7.5 Challenges

Issues facing staff developers in CET include the need to have support from upper management. There is also a need to encourage faculty staff to attend professional development workshops because the emphasis for promotion is on research and not on teaching excellence. As Faris noted:

> *A lot of lecturers are not interested, they receive a salary. They don't feel there is an advantage for this work so that's the most difficult thing. Support from administration would be helpful.*

Lecturers have to be aware that students may learn things differently because students' cultural values are different from those of the lecturer. The researcher noted SQU has a multicultural academic work force, even though the majority of students are Omani. Alaina said:

> *[We] need to understand cultural background and how people learn.*

Other challenges they face are helping staff to redesign learning objectives, and determining how to incorporate learning objectives into the pedagogical design. In doing this they need to design practical activities for staff development workshops. These workshops are helpful for lecturers because as Alaina commented:

> *The design of the objectives is important because the teachers write the objectives and look at what kind of skills need developing for students.*

6.3.5.8 Interviews with the Centre for Information Systems (CIS)

CIS provides support for the information systems needs of the SQU campus community: faculty, staff and students. Ensuring that the university receives up-to-date information system resources involves developing, maintaining and running SQU's computing infrastructure, providing academics with educational resources and operating electronic information systems. The CIS provides training in information systems topics, and develops intellectual and practical resources (http://www.squ.edu.om/cis-center/tabid/454/language/en-US/Default.aspx). One

member of staff from this unit was interviewed.

6.3.5.8.1 The professional development approach

The interviewee, Nabel, confirmed the valuable role of professional development to gain the experience necessary to be a professional developer of staff. CIS provides mainly technical professional development seminars. It also uses new technology and is involved with new projects designed to build a reputation for the university as a leading institution. There is a goal for CIS staff to gain certification from Microsoft through an Iraqi training program. This certification is to help them gain confidence and proficiency in their job.

An annual plan formulated by a committee details the approach to be used when undertaking staff development on the campus. CIS collects from Heads of Department within CIS all requirements to complete technology projects. This allows them to train staff within these projects so as to add value to their project. Nabel noted:

> *This year we have around 15 projects we have to finish within the year.*

6.3.5.8.2 Challenges

The most difficult constraint for CIS is their very limited budget. They are hoping to gain external training contracts. Sometimes they have tried to bring an external expert into the University, but each department has specific needs and these professionals are very expensive as Tarek explained:

> *We have more than 80 staff in this department in the centre and the budget is around 10,000 so the IT, the programs and the courses are very expensive. If they try to send three people in one year it can take all the budget So they are trying to be equal with all staff so that is why they are trying to make some procedures in a proficient way to cover the needs of training and they have to cover rates and also subscribe our stuff and not to concentrate on only one group of people and forget others.*

The training needs differ for each department. Sending one person overseas may consume the entire budget for the year. CIS recommends concentrating on staff development before bringing in technology, with staff considered the most valuable resource in the organisation. It is important to increase the budget for training and to focus on high quality training.

There is an issue with sustainability of achievements because every three years there is a new director, typically with different strategies and a different approach from the previous one as Tarek commented:

> *Now the new director he came for one year he has authorised a new plan… They bring new ideas and we try to use it as long as it helps our services*

6.3.5.9 Interviews with Library Staff

6.3.5.9.1 Aims

The main library aims to have an intellectual influence on the community and to provide a comprehensive and balanced range of high quality information resources. It aims to support both education and research needs, at local and national levels, through the collection, organization, and arrangement of and access to information resources (http://www.squ.edu.om/tabid/5172/language/en-US/Default.aspx).

6.3.5.9.2 The professional development approach

Two interviews with main library staff were undertaken to gather their involvement with professional development. They indicated the library offers refresher programs for all students and academic staff each year focussing on new cataloguing processes. Their own library expertise comes through self-learning and on the job experience, supplemented by attending both local training courses and courses on offer in the Gulf area in countries such as Bahrain, Kuwait, Saudi Arabia and UAE. The library training committee also faces the issue of an inadequate budget. There is a great deal of pressure from staff who want overseas training but there is insufficient funding for all library staff to access overseas training. They consider that staff can be very aggressive in their request for training and question the real benefit of such overseas training. As Salah explained:

> *Some staff are picky they need certain countries. Sometimes they offer them a training program in certain countries and they refuse, there is a change even psychologically and they become very active in their work and wait for the next time.*

Overseas training is mainly concentrated in Bangkok and Beirut. It is considered preferable to bring in expertise from Europe to provide training than to send staff overseas, as this saves time and a great deal of money and can train more staff.

After library staff are sent on training courses they are asked to give a presentation

for their colleagues. The librarians take notes during the training and use these together with their knowledge of the job and what their fellow librarians know to create a program for all library staff when they return. The workshops run by librarians include descriptive cataloguing and subject analysis for library professionals. All library staff need to receive regular training to keep up to date because there is always new information and new trends.

Annual library user evaluation assessments identify staff strengths and weaknesses are these are used to identify which training courses are needed. The training committee's aim is to evaluate librarians, give feedback and have them update skills reflecting the latest developments in the field.

6.3.6 Conclusion

There was a premature end to professional development in Libya. The intended site for professional development was Garyounis University, renamed the University of Benghazi after the Arab Spring. The University is located in Benghazi city which was the location of the start of the Arab spring in Libya. I, the Libyan researcher and academic on leave studying in Australia, lost access to Libya as the site for implementing the professional development program. As a citizen of Libya, studying in Australia, in frequent contact with family and friends at home, I did not suspect such political turmoil. The disruption to the planned implementation of a professional development program in Libya highlights a stark reality for many developing nations. This study confirmed what is reported in the literature. Civil war has a profound effect on educational development! Development in many countries is interrupted by unexpected political events, such as political instability, resulting in a loss of continuity and development being set back. Plans to return to Libya to implement a professional development program were put on hold as I was advised not to return home.

The strongest recommendation from this case study regarding the embedding of technology into mathematics education at SQU is that DOMAS develops a policy for technology use along with a plan for implementing it within the curriculum. A requirement to use technology should motivate the use of technology, in many cases existing technology and software, while facilitating the use of freely available software. Lecturers believe that they would integrate more technology if the shortage

of equipment, such as document projectors and data projectors in lecture rooms, were addressed. To use technology lecturers also need professional development and more technical support so that they can become comfortable with the integration of technology into the classroom.

An examination of how professional development was conducted showed that these practices were similar to those at UOW Australia and at SQU Oman. Workshops followed by one-on-one facilitation to achieve specific learning outcomes are used in both countries. Opportunities to access funding through small grants and large grants were similar. For example, staff at UOW may apply for small internal grants (Educational Development Strategic Funds) and externally through the Office for Learning and Teaching (OLT), which acts to promote excellence in higher education learning and teaching. SQU strives to support and sponsor research activities and projects at all levels. Staff members at SQU have several sources of funds and grants available such as the Research Council of Oman, HM's Strategic Research Fund, and the SQU internal grants (Research project, 2012). However, the scope for funding to motivate developments was, and almost certainly will remain, more limited in Libya.

In this case study staff desire for more recent forms of technology such as a document camera and the interactive whiteboards. This might imply that despite their poor accessibility, these staff considered these tools would be valuable addition for the teaching of mathematics. There are many potential variations on the programs and resources that universities and departments can offer for the professional development of teaching staff. These range from teaching practice guides or funding to attend conferences, to formal teaching programs. Workshops that would be of benefit to staff include:

- Combining open learning to provide across curriculum learning support
- Rudimentary html for web page design
- LaTeX documents for design resources

6.4 Postscript

The opportunity arose to explore the transferability of the workshops through their presentation of two groups of staff and postgraduate students at UiTM (Perak) and UiTM (Malaysia) in Malaysia. This is another developing nation seeking support to

develop its staff in the use of eLearning site. It had one further impetus for professional development, not evident in Oman. UiTM (Perak) was in the process of purchasing Tablet PC s for all 40 teaching mathematics staff to record their lectures to make them available as resources for students. In this instance the presenter was not the researcher and conditions were less than ideal in that 4 Tablet computers were used for a group of approximately 50 and 30 participants respectively. UiTM (Shah Alam) requested a workshop with focus on resources and Tablet technologies.

The evaluation of these professional development programs is based on data collected from 41 participants during December 2013 academic year following the end of the workshops. Surveys were completed by 25 participants from UiTM (Perak) and 16 from UiTM (Shah Alam). The responses for the two workshops are reasonably consistent across the two locations with 100% reporting their interest was held and that they had been given ideas about how to integrate Tablet PC into the classroom with over 90% reporting an overall positive rating for the course, and that they were given ideas about the development of resources for teaching and learning (refer, Table 6.35).

Table 6.35 Malaysian staff ratings of workshop outcomes

Questions	Strongly Agree & Agree Perak		Strongly Agree & Agree Shah Alam	
	N =25	%	N=16	%
1. Overall, positive rating of the course	23	92	15	93.8
2. Interest held	25	100	16	100
3. Participants gained ideas about how to				
▪ Integrate Tablet PC into the teaching process	25	100	16	100
▪ Produce video resources by using Camtasia software.	23	92	15	93.8
▪ Combining learning resources using Learning designs	25	100	15	93.8
▪ Use Evidence based evaluation to guide change	25	100	12	75
▪ Use Summertime Math DVD / or similar	22	88	12	75

Staff were asked for their comments regarding things from this workshop that they would like to apply to their own academic work. Their comments showed an interest in teaching using the Tablet PC in class. This is in accord with the intention in Perak to provide all mathematics staff with Tablet PCs. They consider the workshop to be a success as it provided new knowledge about teaching methods (refer, Table 6.36).

Table 6.36 Malaysian staff comments

Perak	Shah Alam
I would like to apply the learning design approach (2)	Request from the faculty to provide Tablet PC for lecturers who involved to use blended learning
Use of Tablet PC in teaching (5)	More handouts with information (3)
Record my teaching in class using Camtasia software (3)	Assessments and follow up to producing videos
Produce video resources for students(1)	I would like to apply the learning design approach(2)
Save edit and upload my teaching videos into the eLearning site(1)	Use of Tablet PC in teaching (3)
Use of eLearning site (2)	Learn more about video learning resources
Use of Windows journal	I would like to apply blended teaching and designing materials for lecture (2)
Use iPad for teaching process (2)	The training is good as give a new knowledge about the teaching method (3)
More practical example about the use of Tablet and more about video resources	More practical example about the use of Tablet and more about video resources
The training is good and can be implementing in lecturing (2)	
Provide more techniques in teaching and learning	

The workshops were well received in Malaysia, a developing country, in two locations of an institution that was in the early phases of implementing eLearning. This suggests that this type of workshop would also be suitable and timely for staff in Libya. Based upon the results of the workshops in Malaysia and Oman it can be predicted that the workshop will be better received if Tablet technology is to be provided to staff. Following the workshops it is considered necessary to follow-up with mentoring and support of individual staff along with further workshops. The whole of department adoption of Tablet PCs by all the mathematics lecturers in Perak and the associated plan for all mathematics staff to record lectures and upload them to eLearning site is the type of policy decision that would be useful in Oman.

7 Conclusion

This chapter reviews what has been learned from the three case studies on improving mathematics education through the use of technology, particularly in Middle Eastern nations. The case studies highlighted and confirmed several factors with respect to improving education: the nature of professional development to be provided when attempting to integrate technology into the teaching and learning process, the timeliness of the eLearning topic and the need for policies which require the integration of technology into curricula. The chapter involves examination of the similarities and differences between the developing and developed nations in terms of education and identifies areas for further exploration.

The purpose of this chapter is to draw together evidence from the three case studies to address the overarching question "*How can tertiary mathematics education in the Middle East countries, specifically in Libya and the Sultanate of Oman (Oman), be enhanced through the integration of technology?*" and to triangulate upon answers to questions addressed with respect to the need for professional development for teachers in the Middle East.

The exploration of the literature revealed a lot of scope for the introduction of technology without the need for full web capability. Open learning resources are plentiful and can be provided as support resources, or compiled for use in Head Start programs. There are many free software alternatives for packages that are used to enhance mathematics education. Teachers are in a position to enhance teaching and learning experiences for tertiary mathematics students through integrating technology into the teaching and learning process, although they do need professional development. In re-examining the outcomes of the case studies the nuances regarding the nature of professional development and the support teachers require are extracted. This final examination of outcomes is undertaken from two perspectives, a reflection based on the alignment of issues identified in the literature, theories and findings (refer, Table 7.1-7.3), and the evaluation model (refer, Table 7.4), employed seeking to ensure that all necessary design, development, implementation and institutionalisation steps were addressed.

The need for professional development for teachers who are attempting to integrate technology into the teaching and learning process was experienced through all three case studies. In the first case study the need for my own professional development was evident. Reflection following the systematic alignment of the issues in the literature, theories and findings from the first case study (refer Table 7.1) suggested:

- Design with a focus on resources, activities and supports for students learning were practices considered useful for the Middle East; however students want a flat navigational design (no more than two page levels) and effective resources across all topics.
- Good design alone with the provisions of support resources across all topics was not sufficient to improve students understanding. Although performance and perceived competency were maintained in the face of falling baseline skills when students were supplied with a complete set of resources across all topics.
- A number of technologies were identifed as being of potential benefit in Middle Eastern classrooms. These included eLearning, Tablet PCs, video resources.

Also evident in the redesign of eLearning site was the need for ongoing evaluation of outcomes in order to determine the impact of innovation in the classroom.

Table 7.1 Aligning on literature, theories and findings: Case Study 1

Literature review	**Case study 1: Redesign of eLearning site of Math151 at UOW**
• Learning Theories: Behaviourism, Cognitivism, Constructivism, Connectivism	• Design reflected the learning theories as discussed in Chapter 4. No change in perspective or move from the pragmatic paradigm was deemed necessary.
• Learning design o Learning outcomes o Design of learning activities o Provision of learning resources o Design of learning supports o Benefits of learning design	• Student's satisfaction with the redesign and the provision of more resources. Satisfaction also declined despite additional resources when the navigation became more complex, involving three levels. • Good learning design alone, aligning tasks, resources and supports is not sufficient to improve students understanding. Factors such as time, quality tutoring and textbooks are important. • One aim was to determine the impact of learning design on performance, and first analysis suggests the change was to improve the efficiency of learning, with students finding learningless arduous. However performance and perceived competency were maintained in the face of falling baseline skills when students were supplied with a complete set of resources across all topics. • Head Start is a possible means of improving learning.
• The gathering of evidence	• The gathering of evidence was crucial in determining impact, logic suggested that stuents would be happy with a complete set of resources but this was mitigated by what they experienced as poorer design (too many levels) in the final redesign.

The alignment of issues from the literature, theories and findings for Case Study 2, Professional development for technology in mathematics education at UOW, highlighted what technologies could be adapted in the Middle East, and how more could be achieved with existing resources. This study also highlighted the complex multilayered nature of professional development at an organisational level. This complexity is not readily inferred from theories related to professional development. This alignment (refer, Table 7.2) led to the following implications for Middle Eastern professional development:

- Staff need support for many technologies particularly systems such as Moodle but whereas the UOW staff indicated they self-learned for mathematics packages, a number of SQU staff indicated that there needed to be professional development for mathematics packages, as such available packages remained unused in their laboratories.
- At UOW at an institutional level there are multiple approaches to staff development, and such development is often policy driven. An initial first step widely used at UOW is Awareness Raising.
- Many forms of professional development follow the raising of awareness at UOW (such as workshops, individual assistance and online information). According to the Ellis model, knowing how to design is an important second step and appeared appropriate having introduced lectures lecturers to tablets and the creation of resources. Follow-up opportunities are extensive at UOW with professional staff in several units employed to assist lecturers.

Table 7.2 Aligning on literature, theories and findings: Case Study 2

Literature review	**Case study 2: Professional development for technology in mathematics education at UOW**
Literature review: Technologies in higher education	
• Online learning management systems	• Open online learning management systems (Moodle) are used to support learning in Australian mathematics classrooms. • In terms of improving mathematics education such systems were considered to be relevant in the Middle East.
• Delivery of distance education o Videoconferencing o Access Grid technology o Massive Open Online Courses (MOOCs).	• Such delivery methods are used with some groups of mathematics students at UOW, with the rapidly emerging Massive Open Online Courses (MOOCs) offered through online delivery commencing at UOW in 2013. • MOOCs or free were such as Skype free group video or TeamViewer are available for the Middle East. The development of resources is considered and important first step for MOOCs
• Hardware o Tablet PCs o Interactive whiteboards	• Introduction to the Tablet technology, appeared feasible as it was possible to take the technology to the participants, resource creation with Tablet technology, was also a current activity at UOW. • It was not feasible to take this interactive whiteboards to the site of the professional development, so this aspect was not explored.
• Mathematics software	• There are many open source mathematics and statistical software freely available such as SAGE, Maxima and R can be used when integrating technology into the classroom. Open source software can be used to replace some proprietary software and this is important for the Middle East. At UOW not an activity that appeared to warrant professional development, as the mathematicians tended to choose self-learning for this type of software, but at SQU there was some evidence of a need for professional development for staff in this area.
• Web 2.0 tools technologies o Communication and collaboration o Resources: Podcasts and videos o ePortfolios	• Communication has always been an important component in the Middle East in particular with face book and other social networking. • Of particular interest to developing Middle Eastern countries are freely available software tools to create videos and podcasts or resources. Tablet technology was found useful for this in Australia and was considered a worthwhile professional development topic. • ePortfolio could be used the Middle East, but was still extremely new at UOW and less utilised than the tablet technology.

At the conclusion of the second case study, UOW professional development practices were thought suitable for transfer to the Middle East context and this would be examined in Case Study 3, Professional Development in the Middle East SQU at Oman. The alignment of the literature review, theories and findings identified many issues, political instability, cultural differences, professional development, time for professional development and access to some technologies that could and did impact on the implementation of professional development in the Middle East (refer, Table 7.3). Lack of financial support appeared problematic in terms of access to some equipment, but at the same time, software technologies were often available and not used, with the need for professional development cited as an issue. Some issues identified in the literature, such as the quality of education, system of education and teacher training did not emerge as issues in this study.

The third case study drew upon two models for professional development, the Ellis Model and follow up support with suggestions arising for a Community of practice. The 4-stage Ellis model was implemented in Case Study 3. The first stage appeared appropriate with positive evaluations of the Raising Awareness workshops informing participants about existing resources. In the second stage staff were trained on innovative methods for technology integration namely, learning design. The third stage, involved a case study with one member of lecturing staff involved the introduction Tablet technology into lecturing and resource creation, an innovation positively evaluated by students and the staff member concerned. Consistent with Stage 4 this member of staff was willing to mentor or train other colleagues.

The need for followup support, in particular technical support was also evident. Follow-up was undertaken with one member of staff, how to follow-up with a large number of staff would require considerable resources. If an issue were identified and awareness raising workshops were run, there should be a range of immediate supports to convert awareness to ability to apply the knowledge. With the different kinds of restraints on staff time support such as online documents, printed materials, phone call followup, emails, face-to-face consultation, drop in sessions and possibly more advanced workshops can reach more people. Followup may involve many units. Finding ways to create effective communities of practice, learning networks or user groups could help with demands for new skills in institutions where there is a larger need than can be accommodated in one-on-one consultancy.

Also evident from data gathered in this Case study was that staff often do not fully utilise existing facilities and, at least in the Middle East, there was a need to develop a policy for technology use along with a plan for implementing it within the curriculum.

Table 7.3 Aligning on literature, theories and findings: Case Study 3

Drawing on experiences and learning from the UOW context, to design a professional development program for supporting the introduction of technology in the Middle East.	
Literature review	**Case study 3: Professional Development in the Middle East SQU at Oman**
• Literature review: Challenges for Education in Middle Eastern countries	
o Political Instability	▪ Political Instability. The Arab Spring in Libya, had the mot dramatic impact in that the planned educational development was deferred indefinitely. In terms of technology acceptance, the civil war led to an uptake in social media, which will perhaps facilitate education through social media in the future.
o Cultural differences (beliefs and attitudes)	▪ Cultural issues. Teacher centred teaching is seen as consistent with the culture and inconsistent with technology. With multiple teachers on subjects, the teaching culture was individualistic in that if one did not want change specifically introducing technology, the others felt unable to change. Staff considered policy and planning to be important to implement a technology into the curriculum.
o Lack of Financial Support (Availability of hardware and software)	▪ Lack of financial support. This was not seen as a barrier to the introduction of technology. While they are developing countries these were not poor countries, although staff did want access to the tablet technology within their institutions and this would take resourcefulness in terms of accessing a budget such as teaching development grants. There were many instances of technology and software being available that staff did not use but also some instances where staff woud like access to technology such as the Tablets.
o Quality of Education	▪ Quality of education. This did not appear to impact on professional development but the standard of subjects appeared to be higher in UOW than Libya.
o Level of Scientific research	▪ The level of scientific research. This did not appear to impact on the professional development in Oman, although it was problematic for Australian academics. The top three forms of professional development were the same across countries.
o Curricula	▪ Curricula. Overloaded curricula or curricula from overseas did not appear to be problematic when it came to staff contemplating the addition of technology.
o Information and communication technology (ICT)	▪ ICT. ICT in terms of eLearning was adopted from 2001 in Oman, with needs for professional development in this area still evident as it is at UOW although eLearning was introduced in 1997.
o Trained teachers & qualifications o Education system	▪ Regarding poor training of teachers and lower qualifications in the education system no impact on professional development at SQU was apparent.
o Adopting technologies (time for training)	▪ Adopting technologies. In terms of adopting technologies SQU staff had had favourable experiences with eLearning. Professional development is needed for staff to become comfortable with the integration of technology into teaching and pedagocically aware. Issues with staff development remain, staff need time for training and development and staff need access to the new technologies such as document cameras and interactive whiteboards.

The third case demonstrated the need for *Raising Awareness* workshops and how follow up support could lead to not only the embedding of skills into teaching, but to the mentoring of future staff and stepping beyond what had been taught. However evaluation of the outcomes from the third case study called for a reassessment of the entire study in terms of the Alexander and Hedberg evaluation model. How the first

three stages design, development and evaluation were addressed are summarised in (refer, Table 7.4). These first three stages encompassed the first two case studies, in terms of assessing need, software and hardware suitable for use in the Middle East and the actual implementation of the professional development.

Table 7.4 Issues identified through the Evaluation Framework

Phases	Study	Issues raised for Middle Eastern countries
Design	*Literature review*	▪ Highlighted need for eLearning, hardware and software technologies, Tablet PCs, video resources, changed pedagogical approaches to teaching and learning. ▪ The need for professional development. ▪ Open learning resources can be used as learning supports. ▪ Alternative freeware software available for maths
	Case study 1: Redesign of eLearning	▪ The value of aligning resources, activities and supports for students learning and the need for evaluation of innovation, was confirmed as valuable for designing. ▪ Effective navigational and design aspects were identified. Students want a navigational design that is flat, with no third level pages. ▪ Students wanted effective resources across all topics, video and Summertime Math. ▪ Good design alone is not sufficient to improve student's understanding. Factors such as time, quality tutoring and textbooks are important. ▪ Head Start is a possible means of improving learning.
	Case study 2: Professional development for technology in mathematics education	▪ Open learning systems such as Moodle can be used to design learning support. ▪ Open source freely available software such as SAGE, Maxima and R can be used when integrating technology into the classroom. ▪ Professional development is needed to raise awareness of what can be achieved with existing and new technologies. Self-learning is important. ▪ Staff need support to be well prepared for use of a variety of different technologies.
	Case study 3: Professional Development in the Middle East	▪ Professional development is needed for staff to become comfortable with the integration of technology into teaching. ▪ Staff need time. ▪ Staff want new technologies such as document cameras and interactive whiteboards.
Development	Design and development	▪ A selection of workshops developed: eLearning, design, evaluation, using a Tablet PC in lectures and resource generation but other topics such as html remain to be provided.
Implementation	*Case study 3: Professional Development in the Middle East* *Postscript:* Workshops Malaysia	▪ *Raising Awareness* workshops informed participants about existing resources and innovative methods for technology integration. ▪ Staff want policy for technology use along with a plan for implementing it within the curriculum. ▪ Staff need technical support.

The fourth stage in this model is that of institutionalisation and in this instance, due to the limited time to assess sustainability, the one aspect that could be examined was transferability. How robust was the learning and its transfer beyond the immediate context of the innovation? Through circumstance outside the control of the researcher, political instability, the professional development designed for Libya

based on the Australian experience, was tested and evaluated in Oman. That the professional development was assessed as successfully implemented in Oman suggests that the design phase and the actual program of professional development was transferable to another context. Further, the professional development program was requested, delivered and evaluated in Malaysia. This suggested both that the eLearning professional development was timely for countries embarking on elearning and that workshops could be readily transferred. While the model of professional development may remain, the content due to the rapid rate of change of technology will have a limited lifespan and this is to be expected. Detailed examination of findings follows in Sections 7.1 to 7.3.

7.1 Redesign of eLearning

While the focus in this case study was on design in response to students expressed needs, the gathering of evidence in relation to student learning outcomes highlighted the need to continue gathering evidence as changes are made and innovations introduced. The evidence gathered through student surveys at the end of sessions 2010, 2011 and 2012 identified progress made, but also identified when there were setbacks which would not have been evident without the evaluation process. The gathering of evidence therefore became one of the workshop topics for the professional development program.

The student survey feedback provided two starting points for improvement: the provision of resources and the modification of or redesign of eLearning. Most comments were in relation to the provision of more worked examples and the need to improve this aspect of the textbook; students wanted resources across all topics. The design of the *Summertime Maths* resources, which involved a greater variety of resources in addition to video, warrants further investigation in future design as this set of resources was popular with students.

Working alongside the lecturer, the design of the eLearning subject site was modified with a view to improving the subject eLearning design. Implementation of the redesign, seemingly in accord with student wishes, involved altering the structure of the pages and development and provision of more video learning support resources, such as orientation videos and videos showing the process of solving mathematics

problems. The site changes resulted in a change from a site described as "*messy*", and "*ugly*"… to one where the site and navigation was "*very well organized easy to find things*". However the second change in design, although providing more comprehensive resources, led to a decline in students valuing of the site, as the site contained "*too many links*" and "*too many levels*". The steps forward in design as well as the steps backward illuminated design features that needed to be addressed in future revisions and above all the need for continuous evaluation.

7.1.1 Learning Outcomes

The effectiveness of learning designs used to combine learning resources was examined in relation to student learning outcomes. Specifically:

- Improved performance. From the lecturer's perspective, although a significant amount of time and effort has been devoted to MATH151 to improve the learning resources that are available to students, the failure rate in this subject has remained constant in 2010 (36%) and 2011 (36%) with hopefully a move in the right direction, down in 2012 (34%). Although this constant performance is to be viewed in the context of declining student basic skills.
- Confidence. In terms of perceived student competency, "Can do" versus "Cannot do", there was no significant difference in student confidence in their own ability to solve problems in any of the topic areas when comparing before and after the redesigns.
- Valuing of resources. Comparing the numbers of students who found resources useful versus not useful, there was no significant difference in the valuing of any offline resources over the three years except for the valuing of "other work done in your own time" and "consultation with lecturers", both declining in value as resources from 2011 to 2012. In terms of resources available through eLearning, there was a significant difference in the valuing of three of the resources, with the value of *Summertime Math*, *other additional resources* and *orientation videos* declining from 2011 to 2012. Possibly the perceived need for these declined as worked example videos were made available across all topics.

The subject is designed to encourage students to study independently. It is not

ultimately necessary, or expected, that all students would find the time to access all the learning resources made available, nor will all students want video resources. For the top students it is quicker to access print resources. Not all students require or use the same resources. However when students struggle to learn mathematics it is important that they know that there are resources available and that they should use them. In terms of future improvements of MATH151 students' suggestions point to restructuring of the tutorial classes such as "*Tutors need to go through solutions and show us how to do the questions*" and "*to have the solutions to the tutorial sheets available just after the tutorial"*. The textbook (lecture notes) also needs improvement in term of adding more worked answers in the book and "*The textbook needs to have more solutions and to be laid out better*" and a "*short summary of topics covered would be helpful*". With respect to the lecture delivery "*The old overhead projector slides are hard to read messy and slower presentation needs to be improved*".

In terms of lecturer outcomes, the lecturer found the embedding of video resources into eLearning site and concept maps to be a very positive experience. It provided additional mechanisms to explain the subject and its requirements and to demonstrate how concepts introduced in each chapter relate both to each other and to concepts introduced elsewhere. With the continued evaluation of innovations such as worked example videos to satisfy student need, the lecturer and researcher began to focus on emerging needs such as how to best combine resources in an eLearning environment and other approaches such as the *Head Start* program to improve learning outcomes.

7.1.2 Design of eLearning

In terms of applying different learning designs and pedagogical practices, the best use of eLearning site in mathematics requires further research. Initially students voiced their concerns about the design of eLearning. The subsequent first redesign aligned resources, supports and activities together with their temporal sequencing. This led to improvements in students' perceptions as to the functionality of the eLearning site. However, responding to student requests for resources, the second redesign of the eLearning site inadvertently led to students having to access too many layers of pages. While undertaking the website redesigns many issues were illuminated. For example, how to best show the interrelationship between resources,

activities and support, with some students clearly liking the design and resources supplied with *Summertime Math,* its only deficiency being that it did not cover all topics in MATH151.

Several significant differences were observed when comparing the value of design of eLearning site in 2010, 2011 and 2012. Specifically:

- From 2010 to 2011 all design attributes showed improvement with over 95% indicating the design provided for: *clear understanding of what you have do and the resources to help do task*; *knowledge what kind of support you have; eLearning site better access material*; *structure of the eLearning page helps you understand objectives*; *support through difficulties in learning*; *structured to know required assessment*. The final attribute in 2011 *what the lecturer wants is clear* was valued by 88% of students. Possibly this should have been the stopping point in terms of redesign, except that the students had requested more resources.
- From 2011 to 2012 there was a decline in the valuing of all design attributes. The changes introduced in 2011 involved the restructuring of the home pages whereas the structuring in 2012 involved restructuring the second level pages. As part of the 2012 restructure, students began to perceive too many links and too many levels of pages "*eLearning has too many links*"; "*eLearning page is too complicated and moving between pages is time consuming*"; "*Needs simple layout and not too many in and out and one front page with access to all modules*".

7.1.3 Time for Learning

Engaging students in mathematics and the practice of mathematics is problematic. How do you convince students to complete worked examples and practice? Anecdotally, students frequently complain about the time required in subjects. They do not have enough time to complete the required work. Lecturers often indicate that students do insufficient work. The subject outlines state that the time required for an average student to complete a six-credit point subject is 12 hours of work per week (This is a university suggestion). When examining the differences between years, it can be seen that in 2010 a greater percentage of students (50.5%) did less than 6 hours per week compared to say 2012, when only 13.1% of students did less than 6

hours per week. One of the promising findings is that it would appear that students have been more motivated to engage with the required work in 2012 than in 2010, although it may be that student engagement needs to be further increased toward the 12 hours recommended to improve grades. Only 14% of students worked *9 hours or more* in 2010, whereas 23% completed *9 hours or more* in 2012. Therefore a large portion of students in each year completed less than the recommended time for successful completion of the subject.

One of the suggested ways to provide more time to students is to make available a *Head Start* program as was initiated in 2012. It will take more iterations of MATH151, with a current recommendation that four weeks be allowed for the program, an assessment item be available, and, where possible, alternative and complementary materials be made available (Porter, 2014) for its worth in MATH151 to be determined.

7.1.4 Key findings: Redesign of Learning

While questions remain as to some aspects of how to effectively design the eLearning space, the provision of eLearning site itself appears to be of high value to students. The use of eLearning site (Moodle), which is free and is high functioning software, could be a solution to support student learning in the Middle East. For example, it may be very attractive for students who have little learning support outside classes. The attention to resources, activities, support, together with temporal aspects of the subject, is particularly useful in determining the need for additional resources. Students want resources across all topics, although more work needs to be undertaken to identify what types of resources they find most beneficial. Students continued to comment on the value of the *Summertime Math* site which provides a greater variety of resources than is provided on the eLearning site. They received the last eLearning site design less favourably than the first redesign, and this emphasized the value of gathering evidence as to outcomes. It also highlights the need to provide a flat structure in eLearning site design, with level three pages being problematic. It also drew attention to those elements in a blended learning environment that lay outside the eLearning system, such as the quality of teaching and the teaching methods used in tutorial classes. Students want more time on the last topics, integration and differentiation, and more resources in the format provided by

Summertime Math would be useful. While there continues to be opportunities to improve, the changes made to the eLearning site design and the resources provided, helped maintain the pass rate in the face of declining student skills.

7.2 Technologies in Higher Education

This study, through an examination of the nature of practice in the use of technology in teaching and learning mathematics, elucidated the possibilities for teaching with technology in Libya and this was later extended to other developing Middle Eastern countries. Staff and students at the highly ranked Australian university, UOW, were asked, what and how technology is used in mathematics teaching and research. As a second part of this case study the researcher identified professional development strategies used or needed in this institution. The ease at which different technologies could be learned was ascertained in an Australian context. Taken together with the first case study these two aspects led the researcher to determine what practices and technologies were likely to be useful for tertiary mathematics educators in Middle Eastern countries. In this manner the topics for an introductory series of seminars/workshops suitable for use in developing Middle Eastern countries were identified.

7.2.1 Comparing and Contrasting Australia and Libya

An examination of subjects, software and hardware together with professional development practices at the Australian university chosen suggested a number of possibilities for improving tertiary mathematics education with respect to lecturing space, eLearning, software, Internet access, software, hardware, professional development and support.

7.2.1.1 Lecturing Space

Many educators and students use technology in mathematics teaching and learning at UOW. For example, students in the SMAS have easy access to computers in a laboratory to access software packages and tools. The Internet, through both wired and wireless network connections, is available in teaching spaces and elsewhere on campus. Different combinations of technologies are provided for education in teaching spaces depending on the room classification. Technologies may include overhead projectors, screens, projection, computers (PC) including provision for

laptop input, smart board, interactive whiteboards, document camera, video conference and eduStream (lecture recordings). The culture of teaching and learning at universities in Australia is imbued with the use of technology. UOW has moved toward providing more spaces where students can use their own laptops, for example providing electricity points, sitting spaces, outdoor WiFi and, as this thesis is completed in 2014, remote access to laboratory software for students is being trialled.

In Libya by comparison little has been provided in terms of computers for teaching. Following the revolution it may be that greater advantage can be made of the increased student access to iPad and laptops. There is much to be done in Libya if it is to rehabilitate its educational system. The political and security situation needs to stabilize in order for this to happen.

7.2.1.2 eLearning

As established in Chapter 2 two aspects of technology that differ greatly between the Australia and Libya are the use of eLearning systems and the Internet. The spread and rapid change in ICT has resulted in many staff in western universities changing the way they teach. Although not all of the resources used in the west are available in Libya, more use can be made of existing resources. For example, eLearning systems can be used to deliver learning content, to facilitate learner interaction as well as for administrative purposes, although not necessarily with all functionality as provided by plug-ins at UOW. Blackboard was used at UOW, although commencing in 2013 it was replaced by Moodle (http://moodle.org/). Although at UOW students typically accessed Blackboard over the Internet, it is possible to access and make used of eLearning systems through an intranet, as students do when they are on campus. Intranets are available in computer laboratories at University of Benghazi, (Garyounis), Libya. Other functions at UOW such as the linking of student databases to the eLearning system for automatic enrolment of students are not generally freely available, instead requiring specialist programming.

7.2.1.3 Internet access

At UOW all staff and postgraduate students have access, not necessarily unlimited, to the Internet, as do all undergraduate students, via computer laboratories or their

own personal computers. This is in stark contrast to the Mathematics Department at the University of Benghazi. In 2008, when the researcher left her country only staff and some postgraduate students had Internet access; it was not available for undergraduate use in laboratories although students could pay to have access on campus. However, many teaching strategies, such as the organisation of learning resources, which seemingly involve the use of the Internet can be undertaken and through professional development, staff can be alerted to these possibilities.

There has been a growth in use of the Internet in Libya in 2012 compared with five years earlier (refer, Table 7.5).

Table 7.5 Internet use in Libya

Indicator	Level	Units	As Of	1Y Chg	~5Y Ago	~10Y Ago
Internet Users	19.86	Per 100	2012	41.88%	9.00	2.81

* Data source:http://www.quandl.com/society/libya-all-society-indicators

One of key uses of the Internet at UOW is the accessing of eLearning site through both Internet and intranet (internal network). An examination of the functions provided by eLearning systems reveals that there are several steps that can be taken to improve Libyan mathematics education. Even without good Internet access many enhancements can be made to teaching by the use of facilities generally associated with Internet use. These include:

1. Organisation and provision of learning resources. At UOW subjects may be divided into modules in eLearning sites. Within each module students may access resources such as lecture materials, data sets or video clips. However, most of the features of these modules do not require either Internet access or an eLearning system. Interlinked resource pages may be placed on CDs, DVDs or thumb drives, with page viewing requiring only a web browser and not necessarily an Internet connection. Web browsers are readily and freely available, for example Mozilla/Firefox, or Internet Explorer. The html language typically used to construct or code pages can be produced by many html editors (http://www.thefreecountry.com/webmaster/htmleditors.shtml). Alternatively web pages can also be designed for effective learning by freely available languages such as JavaScript and XML.

2. Creation of learning resources. One of the attractive features of web documents is the ability to hyperlink to other images, files or documents.

Video clips can be created on a Tablet PC with packages such as Camtasia Studio or freeware alternatives such as CamStudio. Using videos is a way *"to provide a strong background context for the technical aspects of the course, either by performing live demonstrations or by presenting relevant examples and anecdotes in class"* and through this to *"facilitate the development of physical intuition and accelerate the process of gaining experience"* (Micolich, 2008, p. 193). Hence, the demand for video resources is significant in higher education not only on the part of students but also from teachers (Kaufman & Mohan, 2009). Different genres of video for student use have been developed at UOW (Porter & Denny, 2011) and these could be readily developed in developing countries such as Libya or Oman, making use of English or other languages. Alternatively, use can be made of a multitude of open access resources as provided by groups such as the Khan Academy.

3. Overcoming technology limitations. While laboratories might not be available, web pages can be accessed by a teacher and shown to students in a classroom using a data projector and computer. The data projector would be a priority purchase for use with existing computers. The provision of this infrastructure may be a useful next step toward including technology. Further, under circumstances of restricted Internet access web pages, including accompanying features, can be made accessible to students by supplying them on a DVD or an alternative storage system.

While the Internet is required for communication with the world, an intranet may be sufficient for communication or email within a university, along with the provision of learning support resources.

7.2.1.4 Software

Aligned with the analysis of laboratory software was a search for freeware or open source software that could be used as alternatives in developing countries. This process generated questions as to what functionality is available in both the original and the alternative software. Mapping of subjects suggested that while specific subjects were likely to be different in the Middle East to those in Australia, similar topics were covered during the degree. With little postgraduate work in both Libya

and Oman, and hence little demand for specialist procedures, the free open source software R would be suitable for Statistics subjects, RStudio and GGobi for graphing data and the WinBUGS statistical software for Bayesian analysis. For mathematics subjects, open source packages such SAGE would be useful in subjects such as Analytic Geometry, Linear algebra, Calculus and Differential Equations which involved symbolic manipulation. While workshops are available for UOW students and staff on the major statistical packages used (SPSS, SAS and JMP) staff tend to self-learn the software packages used in mathematics.

Additional guidance regarding the diverse function and uses possible for these software tools is provided at sites such as, SAGE (http://www.sagemath.org/) or the open source site (http://www.opensourcemath.org/). Such sites can assist with self-learning, as undertaken by many UOW mathematicians. There are also sites providing security comparisons, file systems, networking capabilities for open source operating systems (http://en.wikipedia.org/wiki/Comparison_of_open_source_operating_systems).

7.2.1.5 Hardware

The major technology used in developing countries is the PC. The experience with the use of Tablet PCs reveals flexibility in delivery, an ability to support active learning and provide an exciting learning environment for students. With regard to the use of the Tablet PC in teaching, the Head of School at SMAS reported on the use of Tablet PCs by lecturers as follows:

> *I consider the shift from computer presentations to the use of tablets to be at least as significant as the shift from overheads to computer presentations. The best and most awarded teachers in the School appear to agree with me; they have been specifically asking for tablets as their computers come up for renewal. This in itself is a stronger endorsement than any I could make as an individual (Porter & Denny, 2011, p. 36).*

One lecturer reported on student feedback: "*students find this immensely helpful as they can concentrate on the discussion, rather than try to write down everything I write down to make sense of later*". "*Tablet PCs are also extremely useful for the creation of resources and the capture of classroom teaching"*. Student feedback regarding the use of the Tablet PC in mathematics is positive, with comments such as the *"the presentation method is very helpful. His method of presentation which uses the computer tablet is very effective when explaining examples and drawing diagrams".* A switch to adopting the Tablet PC rather than a PC would require a shift

in policy in Libya, although it is plausible that staff when seeing these, as many did at UOW, will seek to shift to the tablet technology when renewing their university-provided computers (Porter & Denny, 2011).

7.2.1.6 Professional development and support

The surprise that came through interviews with staff in Australia was the depth and extensive nature of the available professional development. Staff use of different technology in teaching is supported both from technical, learning design and policy perspectives. Professional development at the level of the organization is complex, involving meshing of support systems. Many staff and units at UOW work to provide motivation and support for each other by sharing ideas, information, abilities and experience. Extensive work is undertaken to provide opportunities to train academics, and to increase staff awareness of what can be achieved. The provision of workshops is but one component of professional development. The development of communities of practice is a possible way forward in Libya by sharing the knowledge and experience of staff in the absence of formal professional development structures.

At first glance it seems that there is so much available to universities in developed nations and so little available for universities in developing countries. While Internet infrastructure is being introduced in Libya there is an opportunity to develop staff in readiness and at the same time to develop and improve the teaching and learning environment. The natural extension of this thesis is the development of an in-service *awareness raising* program, allowing staff to more extensively use the tools that are accessible.

7.3 Professional Development in the Middle East

The researcher started with a review of the Libyan and Omani higher education contexts and outlined challenges that must be overcome before technology such as eLearning system can be successfully introduced. Examination of available mathematics subjects and available technologies at the University of Benghazi allowed progress to be made towards understanding how the restrictions of limited infrastructure can be overcome. The final component of this case study involved the implementation of a professional development program. This induced reflection

upon the transferability of the program, institutionalising professional development, and in particular the need for appropriate policy.

7.3.1 Differing Contexts: Australian, Oman and Libya

Several differences were noticed between the Australian, the Omani and the Libyan contexts. These differences suggest practices could be improved in Oman and Libya:

1) Most mathematics subjects at UOW are offered using new approaches to teaching, new technology, computation, visualization, support and collaboration. In DOMAS and Libya mathematics subjects are offered using the traditional combination of lectures and tutorials for problem solving. In Australia, student-centred teaching approaches, that encourage self-learning rather than transferring of knowledge by the teacher, are used. This was not happening in Oman where teachers use traditional "chalk and talk" methods focusing on content transmission rather than facilitating students learning on how to think. Staff at SQU (Oman) argued that student experience and culture is compatible with this method and further that they are comfortable with this type of teaching. In Libya there has been a tendency for students to learn by memorisation rather than by reasoning and meaningful learning (The General People's Committee of Education, 2008). Teachers there have little experience of modern educational methods, which implement strategies to build skills and engage students in thinking and analysis, or even in using technology. Professional development is needed to assist in the development of teaching that involves new learning approaches.
2) The structuring of classes is undertaken differently. The class size of students in Australia is much larger than in Oman. In Australia, a first year subject may contain large groups of students (100-500), with smaller tutorial groups (15-25) being taught for the most part by different teaching assistants. In Oman many lecturers teach the same subject with small groups of students. When some of these lecturers do not agree to use technology in their teaching then technology is not integrated into the teaching for that subject. The provision of responsibility to one or two staff members to co-ordinate and assume overall responsibility for embedding technology within the mathematics subject in all classes could lead to technology use in at least some subjects in Oman. Libya also follows the model of large classes (50-

100) except for advanced classes where the numbers are small suggesting that engaging individuals rather than the many could lead to the inclusion of technology into subjects.

3) In Australia students have many kinds of technology support available from the university level to the departmental level; whereas in Oman and Libya students have little support. Mapuva (2009) argued that the introduction of ICT into higher education would require institutions to support students in adapting to unfamiliar learning contexts. There are many freely available resources for mathematics subjects. Using technology and learning designs incorporating collections of good resources aligned with subject content could fill some of the gap in learning support for students. In the Middle East access could be provided through the provision of eLearning system over intranets, or using storage devices such as DVDs, CDs and memory sticks.
4) In Australia there are competent technical staff to provide rapid response by email or phone while in Oman there are insufficient technical support staff. Currently, at SQU Oman there is only one technical support person in DOMAS with an intention to provide two more, to ensure the smooth running of laboratories and to answer computer related queries of the staff. Ani (2008) at SQU also found a need for technicians at SQU who are willing to help students in dealing with technical problems. An increase in funding would enable developing countries, such as in Libya and Oman, to provide technical support and proper training to update their skills and give assistance to both academics and students. In the absence of funding, encouraging user groups or communities of practice, where users help other users, might be a useful strategy.
5) Technology in lecturing spaces differs. Staff at UOW use a wide range of different supported technologies in teaching. Only some of this equipment, such as computers and data projectors, are widely available in Oman but none in Libya. The provision of loanable mobile projection facilities, Tablet PC and laptops, could be a solution until lecture theatre equipment is provided.
6) Three of the most notable resource differences between UOW, Oman and Libya were: Internet access, the use of eLearning systems and the variety of mathematics and statistical software available. Most subjects at UOW have an eLearning site, similarly in Oman where an equivalent proportion of

faculty members use WebCT as they do at UOW. In Libya there was no eLearning system until 2009. The challenge was to identify an infrastructure which can be made available to support student learning, and in particular mathematics learning, in locations where few resources are available. Possible solutions were identified through an exploration of the components and functionalities of the technologies.

7) Many subjects and lecturers at UOW routinely undergo evaluation. Although this may be for the purposes of application for promotion, in many instances it is to gather input as to why students are failing, and how to improve subjects. In Oman lecturers routinely underwent evaluation for the purposes of application for promotion. However, in Libya there was no kind of evaluation until 2009. It was also evident that staff need to undertake ongoing evaluation of subjects to ensure that innovations in learning lead to improvements in student learning outcomes.
8) Students at UOW use mathematics software packages such as Mathematica, Maple or MATLAB. Although SQU has acquired licenses in adequate numbers for students, these packages are infrequently used by students and not used in teaching. The lack of software use in teaching in Oman was associated with the need for professional development to use software. Software such as this is not used in Libya, although free software is available for use. Given the similarities to Oman, professional development on how to use software is likely to be needed.
9) All staff at UOW have a PC in their office (except a few who choose other computers) connected to the university network. In Libya staff have a PC but in 2008 they were not connected to a university network. Many UOW mathematics staff have elected to replace their PC with a Tablet PC and SMAS has purchased a number of Tablet PCs to loan to staff (Porter & Denny, 2011). A similar shift in Middle Eastern countries could provide beneficial outcomes in terms of both lecturing and the creation of resources, particularly if combined with inexpensive mobile projections systems. The Tablet PC loan system can be useful for Oman and Libya where the purchase of just one or two Tablet PCs for loan could allow their use in many different subjects.

7.3.2 Professional development programs

Training of academics is required to increase their awareness as to what can be achieved. For instance, limited or no Internet access does not mean that applications such as web browsers and linked documents cannot be used. Alternative pedagogical approaches can be provided from Internet applications accessed in an offline capacity. The training program developed and delivered in Oman aimed to make staff aware of the significance of technology for student learning outcomes, ie.it was for *Raising Awareness*.

As evidenced by data collected at UOW, professional development in an organisation is multilayered, involving multiple units, multiple topic areas and diverse staff. There are many potential variations on the programs and resources that universities and departments can offer for the professional development of teaching staff. Given the nature of professional development at UOW, it is likely, from an organisational perspective, that multiple approaches to staff development are necessary to provide deep and rich training. Such activities range from teaching practice guides, funding to attend conferences, formal teaching programs and the development of rich, multilayered, support networks. To design a comprehensive professional development program for developing countries, several factors appear important:

1. Evaluation. Evaluation will determine what the needs are and what is to be achieved. As found in this study, identifying the gap between the best practice and what is available in universities in developing countries is a useful first step to suggest ways to make improvements or to target innovation. As found by Apul and Latham (2009) understanding local needs and conditions involves the evaluation of staff skills and abilities. Such evaluation can also be used to determine standard teaching practices and to provide insight into how to bridge the technology gap. Understanding academic access to and the use of technology is essential for acquiring a sense of future professional development needs. The results show limited availability of more recent forms of technology (Tablet PCs, SMART boards) in Oman. However, tutors and lecturers indicated a desire to have training on these particular resources. Two questions to be answered are: What is the department's ability to integrate technology into teaching? What skills do

staff need to integrate technology into the curriculum? Ongoing evaluation will provide feedback on innovations introduced, on workshops and on training so identifying whether staff needs are being met.

2. Community. Professional development programs need to establish a community throughout the university focused on the integration of technology and creating an atmosphere centred on the university philosophy, mission and goals. Within this type of community staff beliefs and attitudes can be changed while their abilities are expanded. For this to happen support must be provided for academic staff to learn the foundations of how to integrate technology into the curriculum, so that they can begin to blend technology into their teaching. Communities of practice can be used to guide the reform process and support academics across the university. Committees that operate around educational policy and practice provide important avenues for staff to collaborate.
3. Open communication. Use an open communication style to support professional development. Share information and knowledge gathered through evidence based research on teaching and learning or through discussion. Gaining experience can help bring change.
4. Introduce technology. An important step in professional development is an introduction to the use of new technology, including pre-designed foundation seminars or workshops. UOW has an effective method for introducing technology to staff through workshops conducted by in-house and external experts. The introduction of technology begins with the foundations of use of technology and this is systematically followed with contextualizing these foundations in curricular areas and university-wide policies and practices.
5. Workshops. Workshops that provide staff with opportunities to practise in a safe environment and to share ideas with colleagues need to be well designed. The design of guidelines that identify necessary components that should be included in Faculty workshops on the use of technology is required. For example, workshops can involve educating staff on how eLearning system can be best used and implemented into a subject. A workshop can show how to improve the use of existing or open sources technology to provide better outcomes for student learning. Such workshops are sufficient for raising awareness, for networking and for providing information and offer staff an

opportunity to use, discuss and refine techniques.

6. Support. Support should be provided in different ways such as consultations with experts or self access online based resources through the website. At UOW print resources are also made available to staff, so that if a staff member cannot attend a face-to-face session, or does not want to, they can take these away or access published information on a website. Resources should include a variety of contact details including phone numbers, email addresses, web URLs and websites allowing academics to explore further according to their expertise.
7. Useful opportunities. Provide faculty and staff with opportunities to continue developing through sharing ideas about their learning and trials in the classroom. Useful options include:
   - A web forum wherein staff can engage in conversation with colleagues on how to best integrate technology, sharing thoughts as to ways to teach with technology in a variety of subject fields.
   - Project work providing academics with opportunities to practice, learn, reflect and accept advice from experts in order to encourage them to exercise and design authentic experiences.
   - Regularly scheduled discussions.
   - Access to publications and other resources.
8. Long-term professional development. Professional development programs need to take a long-term approach to gradually improve staff capability to do a better job. The initial stages involve more intense focus, particularly in providing resources and creating the needed support to faculty as they develop their understanding of integration technology. This involves series of workshops and consultation with experts in fostering the appropriate use of technology into the curriculum.
9. A culture for change. Creating a culture for change and organizing the change process facilitates the introduction of any innovation, including innovation with technology.
10. Time. There is a need to liberate time for training staff as currently staff, lack time to learn new technologies. These conclusions are supported from previous research conducted at SQU across four departments in the College

of Applied Sciences by Al-Senaidi et al (2009).

11. Reward and recognition. Reward and recognise lecturers who have good teaching practice. This is an important strategy that is used in career development, providing motivation and promoting good teaching. This will allow staff in developing countries to develop their capacity to innovate and rethink their ideas about the quality of teaching and the nexus with research in their disciplines.
12. Policy. While there are many opportunities for staff to introduce technology, these are often not pursued. One necessary change in developing countries to bring about innovation is the introduction of 'policy' and guidelines to ensure changes.

7.3.3 Institutionalisation

The final stage of evaluation, institutionalisation in the Alexander and Hedberg model (1999), requires time; time for the impact on institutions to be witnessed. This is the last stage of evaluation. In terms of effecting change in the Middle East, transferability of the professional development from one country to another is of importance.

7.3.4 Follow-up case study

Raising Awareness workshops were considered to be just that, with follow-up support deemed necessary to embed practice. As shown in the trial use of the Tablet PC it is possible to facilitate the integration of technology into teaching. For example, as happened in the case study of one lecturer with a Tablet PC, the use of Maple and MATLAB in lectures, the use of pdf Annotater software to create resources, the provision of notes with gaps provided live working and capture of examples.

This lecturer extended her use of technology to create a new Moodle page for the mathematics subject including online quizzes and a discussion forum. Furthermore she developed video e-resources across all topics with the aid and support of the *Center of Educational Technology* and *Teaching and Learning Department* in SQU. She was prepared to take on a mentoring role with other staff in the use of technology, an embryonic step toward developing a community of practice.

7.3.5 Interviews and surveys of participants

Lecturers from Oman and Malaysia had positive perspectives as to their future use of the Tablet PC, their own production of resources and how to use learning design in the eLearning. Staff in Oman said that "*Tablet PC is the best for teaching*", "*Very good program*". Malaysian Staff indicated that *"training is good and can be important for lecturing"*

Transfer between Middle Eastern nations is quite feasible, because of the connection between regions. Africa, especially North Africa and the Middle East, connection is not only cultural but also in some aspects technological, wherein due to their geographic location, technology can be readily transferred between countries in these regions (Fathurrohman, 2013). What works in one country in areas such as the Middle East, is likely to work in other developing countries from the same region, therefore it is highly likely that professional development programs will transfer successfully from one Middle Eastern country to another.

7.3.6 Transferability

As a Middle Eastern researcher experiencing professional development in an Australian community and delivering professional development in a Middle Eastern community, no differences in planning or delivery appeared necessary. Recipients require well-designed, current materials, presented in an interesting and timely manner. Staff indicated they would like to attend workshops that showed how to integrate computers into the curriculum. Staff needed to understand pedagogies that address different learning styles and teaching needs. They needed to understand where ICTs could facilitate transformation, including what they can do and how ICT can be used. Libyan academic staff, the initial focus of this study, need to be trained in both the use of new technology, so that they become familiar with it, and in the effective use of it in teaching.

That the seminars on eLearning site and the use of resources, planned for Libya and delivered in Oman, were requested by two campuses of UiTM in Malaysia, also a developing country new to eLearning, suggests that the topics chosen are timely for developing nations. Malaysian mathematics staff in Perak, though a bold policy decision and grant funding, were moved to Tablet PC technology, suggesting

possibilities for other nations. In Perak, where the whole of the School changed to Tablet PCs and decisions were made to upload all lectures and class work to the eLearning system, resulted in the beginnings of a community of practice where staff helped each other. The adoption of Tablet PCs by mathematics lecturers in Perak and the associated plan for all mathematics staff to record lectures and upload them to eLearning site is the type of policy decision that would be useful in Oman and Libya.

7.3.7 Need for Policy

The DOMAS, in Oman, has sufficient computer laboratories, computers and licences for software packages such as SPSS, MATLAB, and Maple. However, staff comments suggest such software is not widely used in teaching, with "*people are not using what they have*" suggesting additional workshops need to be run on software.

> *We do have resources and we have no one using them because of lack of experience. We need departmental policy to use the computer and implement them in the course.*

To motivate staff to embed technology into their teaching staff, the need was noted for departmental deliberation and planning to integrate technology into the curriculum.

> *People have different opinions about technology. We have six laboratories and computers without software but they have Maple and Mathlab licenses but it is not embedded in the curriculum, and the syllabus outcomes do not mention any of use technology. When we have a team one of them will say "no" and no one will use it. For example, the team of the subject responsible for say elementary calculus - if someone wants to embed software use and others do not, no one accepts it because it is not in writing or mentioned within the syllabus. It should be enforced for staff by being written in the syllabus to use the component of technology*

Staff clearly indicated that DOMAS needs a policy for introducing eLearning system and software packages such as Maple. "*If there is no policy some might do it others may not if it is not written in the requirements*". Such policy decisions can have an impact. For example, in 2014 the entity of the mathematics faculty at UiTM (Perak) is to use Tablet PCs to capture teaching for uploading to eLearning. This policy together with the provision of Tablet PCs for all staff and the *Raising Awareness* workshops developed in this thesis has provided impetus for staff to integrate technology into teaching. Follow-up professional development is part of this plan.

Policy could include a vision as to the method of introduction such as provided by

Al-Khanjari at el (2011) who recommended to the College of Science at SQU, the introduction of eLearning system in a stepwise manner using a subject management system (refer, Table 7.6) This process could be appropriate for other developing Middle Eastern countries such as Libya.

Table 7.6 eLearning phases

Phase	eLearning
1	Deployment of course outline, lecture notes, assignments and list of events in online
2	Introduce online study tools (e.g. mail, forum, chat, etc) to support interactive learning at peer level.
3	Use of online quizzes using Moodle at least for the courses requiring small labs
4	Use of online quizzes and tests using Moodle and special tools for all courses requiring small to large online labs

7.3.8 Recommendations for further research

There was extensive policy behind the integration of technology into the University of Wollongong teaching and learning environment. There was a clear call for policy regarding the integration of technology in Oman. There was a successful whole of school initiative in Malaysia. Questions remain as to how those policies were developed or should be developed. To what extent are policies institution led, or led by users? What is the consultative process that is necessary to ensure that the policy is good policy, well received, enacted and has a reasonable funding model.

The learning design approach aligned, tasks, resources and supports, and until resources were supplied across all topics there was a request for more resources. That this alignment at best maintained performance in a context of declining baseline skills refocuses attention on the nature of tasks provided, and raises of questions as to whether students could be provided with more engaging tasks, tasks which better elicitated the theory and methods with which they were engaged, or could it be that the resources themselves need improvement, and if so in what way?

Follow-up support is necessary to convert awareness to an ability to integrate technology. Follow-up support may involve many developers and units with a variety of approaches. One-on-one consultation is likely to be costly in terms of resources so at an institutional level ways to develop staffs self-learning with technology capacity might be an important focus for professional development. Moving beyond self-learning how to facilitate communities of practice would also be worthy of investigation if these aid the many to develop expertise.

7.3.9 Conclusion

Adopting technology-based teaching approaches requires more than technological infrastructure. It requires an investment in professional development and building awareness, a culture to infuse and adapt innovations, establishment of strategies, policies, regulations and quality assurance procedures, and the training of faculty members to enable technology transfer (Al-Musawi, 2008). In developing countries much can be done with existing resources and poor Internet access, as utilities such as html, web browsers and linked documents do not require the Internet, they can still be used in powerful ways. Browsers and html allow reshaping of how educational materials are organised and made available to students. Alternative pedagogical approaches can be provided from Internet applications accessed in an offline capacity. For example, Moodle in its basic forms is a freeware eLearning environment that can be used over an intranet when full Internet capability is unavailable. In mathematics and statistics there are freeware alternatives such as SAGE, Maxima and R to many software applications. In terms of bridging the gap between Eastern and Western countries, the challenge is to incrementally introduce, trial and evaluate these possibilities in Libya and other developing Middle Eastern countries. This will increase awareness of the educational possibilities that will arrive with full Internet capability. It is also apparent that professional development is a key part of the solution to the problem of how to integrate technology into teaching and learning.

Professional development regarding areas such as eLearning, html, learning design, the use of different software and pedagogical approaches is timely, with developing countries such as Malaysia, Oman and Libya seeking to introduce how to integrate technology and to direct these changes. Whatever professional development program or provision of resources is made it is essential that policy requires staff to begin the process of integration of technology into teaching and further, that the steps toward improvement be evaluated.

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Appendix 1:
Student Participant Information Sheet

Dear Student,

The purpose of this survey is to evaluate the impact of learning resources provided to students and identify and develop ways to support students to learn strategies that help them to learn more efficiently and to give them a better opportunity to successfully complete this subject.

This survey is to provide feedback that can assist in the development of the subject for future students. The subject is experienced in various ways. Some students attend lectures, others use only the online materials and some use both. Some students spend many hours studying with learning resources, others a few hours. Some resources are more useful than others. The overall design of the subject as well as types of assessment may be important in facilitating learning understanding.

Students enrol in a math subject from different disciplines. A math subject that is hard for one student may be easy for another. This research involves the examination of learning resources provided to students with a view to identifying how we can best improve those resources to bring about better learning outcomes. We are asking you to complete an anonymous survey this week evaluating the usefulness of a variety of learning resources. This will be handed out in lectures. The survey will take approximately 15 minutes.

Because of the University's ethical guidelines for research, participants need to be informed of the nature and purpose of the research, the procedures involved and their rights. That is the purpose of this Information Sheet. Participation is not compulsory, but encouraged because of the anticipated benefits to all students. There is no penalty for not participating. The choice remains yours. The final published results of the research will be aggregated measures and there will be no features that could lead to the identification of individual students.

If you have any questions in relation to this research please do not hesitate to ask. Your questions and comments are more than welcome. If you have any concerns or complaints as to how the research is conducted you should contact the Secretary of the University of Wollongong Human Research Ethics Committee on (02) 4221 4457.

Thank you in anticipation of your willingness to participate in an attempt to improve learning in this subject.

Appendix 2:

Academic staff, student Participant Information Sheet

Dear member of Academic staff, student
There are many limitations in technology in developing countries in terms of hardware, software and expertise to take advantage of what is available. The purpose of this interview is to identify ways to develop mathematics and statistics capabilities in developing countries taking advantage of what has been learned elsewhere. The broader aim is to help close the education gap between developed and developing countries. In this work I am developing a package for professional development and gathering evidence in terms of its success in improving student learning outcomes.

Lecturers deliver courses in mathematics and statistic subjects in different ways. Higher level students and staff research and use a variety of different technologies. We are asking you to participate in an interview this week to generate information regarding which technologies you use or you don't use, how they are used and what you and your students gain from their use and importantly which technologies you may wish to use but currently do not.

The interview will take 30 – 60 minutes. These interviews will be used to investigate possibilities for professional development to attain your specific objectives and conducted in an Omani university. The professional development will be conducted through seminars and working alongside staff. I am interested in researching the introduction of technology and in particular learning designs and video resources in mathematics. These interviews constitute preliminary work for a doctorate that will examine ways for developing teaching/technology skills with a view to introducing some new technologies/approaches in to teaching. The impact of this on students is also to be examined.

Participation is not compulsory, but encouraged because of the anticipated benefits for students and staff in developing countries. While the data is collected in confidence and intended for reporting under pseudonyms, because the analysis is by year and subject matter, anonymity cannot be guaranteed in the local context. We wish to be sensitive to your use of these ideas. To do this the interviews will be transcribed and returned to staff, so that staff may withdraw or correct any comments and information….

Appendix 3:

Consent form

I have read the information presented in the participant information sheet about the project "Improving mathematics education in developing countries through the use of Technology" being conducted by:

Dr Anne Porter _alp@uow.edu.au , Dr Mark Nelson mnelson@uow.edu.au
& Bothaina Bukhatwa bfab852@uowmail.edu.au

School of Mathematics and Applied Statistics University of Wollongong.

I have had an opportunity to ask questions related to this study and to receive satisfactory answers to my questions.
I am aware that I have the option of allowing my interview to be audio recorded to ensure an accurate recording of my responses.
I am also aware that excerpts from the survey and/or interview may be included in the thesis and/or publications to come from the research, with the understanding that quotations will be either confidential or attributed to me only with my review and approval.
I was informed that I may withdraw my consent at any time without penalty by notifying the researcher of this wish.
This project has been reviewed by, and received ethics clearance through, The Office of Research Ethics at the University of Wollongong. I was informed that if I have any concerns or complaints as to how the research is conducted I should contact the Secretary of the University of Wollongong Human Research Ethics Committee on (02) 4221 4457.
With full knowledge of all foregoing, I agree, of my own free will, to participate in this study AND to have the in-person interview and audio-recording of the interview.
____ Yes ____ No
I agree to the use of anonymous quotations in any thesis or publication that comes of this research.
____ Yes ____ No
Participant Name: ---
Participant Signature: -- Date: ---------------

Appendix 4:

Request an appointment at UOW

……. I am currently studying for a PhD at the University of Wollongong, Australia. Some staff advised me to contact you and I would like to interview you, if you don't mind. The aim of the interview is to identify and develop effective staff development strategies for introducing new technologies to staff. I am evaluating strategies and approaches for undertaking staff development used in one of Australia's top universities, the University of Wollongong (UOW). The intent is the development of a professional development program for staff in the Middle East.

In regard of this, I would like to request an appointment to conduct an interview with you, please.

Appendix 5:

Head of School's Invitation to participate

Dear all, …. a research student in the School of Mathematics and Applied Statistics at the University of Wollongong, is currently visiting the Sultan Qaboos University in the Sultanate of Oman in order to conduct research related to professional development on "Mathematics education and technology". Her visit is sponsored by the SQU office of External Relations and she is currently hosted in the DOMAS. She would like to conduct a survey and interview the faculty members of DOMAS. The purpose of these interviews is to identify ways to develop mathematics and statistics capabilities in developing countries taking advantage of what has been learned elsewhere. The broader aim is to help close the education gap between developed and developing countries. In this work, she is developing a package for professional development and gathering evidence in terms of its success in improving student learning outcomes. I would really appreciate your help in completing the survey form which is already distributed in your mailbox and also in contacting Ms. Bothaina on her email (bfab852@uowmail.edu.au) suggesting times suitable for your interview. The survey forms should be returned to Beni by March 4 as much as possible.

Appendix 6:

The workshop invitation

Table 7.7 The workshop invitation

The PhD Student Bothaina Bukhatwa, is arranging a workshop "Improving teaching and learning through the use of technology " for all the staff , If you would like to attend the workshop, please select your suitable time and send it back to me.

Appendix 7:

Workshop timetable

Improving teaching and learning through the use of technology
Workshop
2012
Sultan Qaboos University

Tablets will be provided at the workshop so places are limited. If you are able to attend the workshop please write which day, date and time you can attend from 28Feb-7 March. You may choose more than one time slot.

Please register and return to the secretary

Name: Email:	10-12	12-2	2-4
Saturday			
Sunday			
Monday			
Tuesday			
Wednesday			

Training Sessions will focus on:

Session 1: Tablet PC technology
- Presentation Integrating Tablet PC technology into the teaching process – why and how

Session 2: Camtasia Studio
- Using Tablet to produce different genres of video resources by using Camtasia software.
- Steps for producing video in the process
- Group exercise

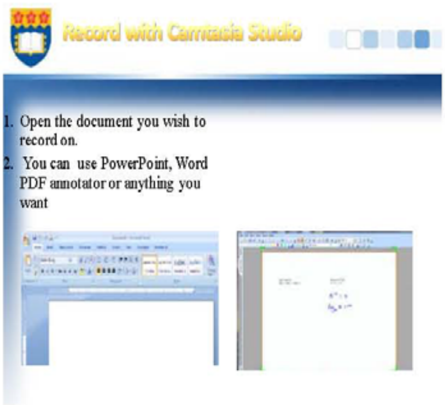
Session 4: Learning design approach
- Learning design approaches for improving the combination of learning resources,
- Evidence based evaluation to guide change
- Group discussion: Positive and negative impacts of technology on development and students learning outcome

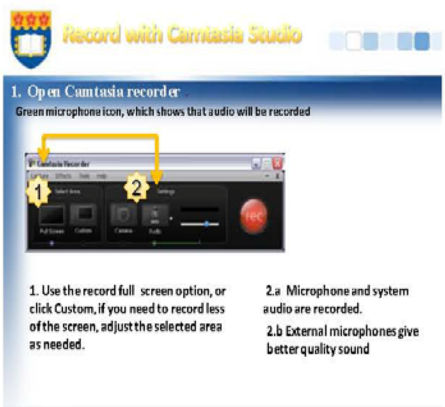
Appendix 8:

Workshop time and location

Hi all,
I just inform you that the workshop will be held in DOMAS LAB B(2210),
New building 2nd floor, behind Prayer room on Saturday at 10 am,
Thank you

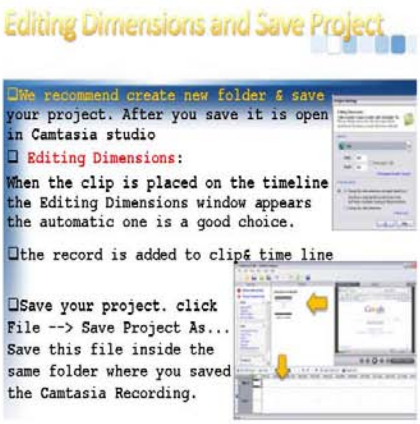
Appendix 9:
Camtasia Studio documentation






Get start with Camtasia Studio
To start recording you can either
❖ right click on the red recorder icon or
❖ press F9 on your keyboard.
To finish recording
❖ press F10 on your keyboard,
❖ the stop button on the recorder toolbar,
or
❖ right click the recorder icon in the task bar and choose stop.


Over view of the Camtasia interface
a preview window
1., 3. Save and Edit: Save it to a preferred location, and then add it to the Camtasia Studio timeline.
Save this recording file and close the preview window.
Edit
Save and open the recording file in Camtasia Studio for editing.
Save
Delete
Edit
3. Produce: Click to save your recording, bypass editing, and open the Production Wizard.
Produce
2. Delete: Click if you do not want to keep the recording.
Delete
Permanently delete the current recording file.


Editing Dimensions and Save Project
❑We recommend create new folder & save your project. After you save it is open in Camtasia studio
❑ Editing Dimensions:
When the clip is placed on the timeline the Editing Dimensions window appears the automatic one is a good choice.
❑the record is added to clip& time line
❑Save your project. click File --> Save Project As... Save this file inside the same folder where you saved the Camtasia Recording.

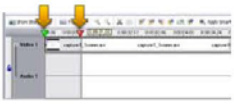
Zoom-N-Pan properties

To edit the zoom level of any key frame on the timeline:

- opens the Zoom-N-Pan properties window where you can change the scale and duration of each selected zoom key frame.

Cut Unwanted Video and Audio on the Timeline

1. Zoom in and Zoom out on timeline to make precise editing easier.
2. The playhead has a green inpoint and a red outpoint. You can drag either one to make a selection on the timeline



Cut

Allows you to remove a section of your timeline.

1. place your playhead at the beginning of your video.
2. Click and drag the red outpoint until you reach the end of the first line of the script.
3. Click either the Edit then cut selection scissor icon, or control + x.

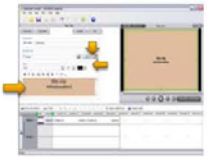
Transitions:

Transitions are effects switch between two clips on the timeline.

1. Click the transitions tab to choose a transition for the project.
2. Click and drag the Transition of your choice between the Title Clip and your video on the Storyboard.

Add a Title Clip

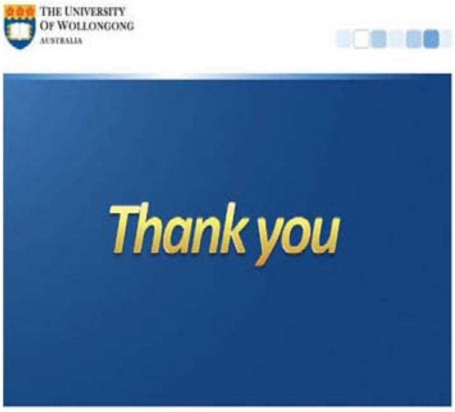
1. Title clips is helpful to introduce or to conclude your video .
2. click on title clip tap in the beginning on time line
3. Write any thing you want
4. you can change color of writing and background



Audio Enhancements

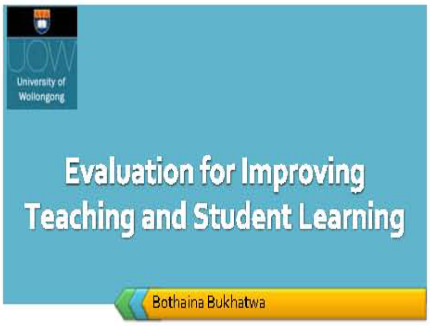
1. Manually select region to make sure the audio is clear and easy to understand
2. remove noise.
3. Chose automatkly
4. Chose high for Volume level

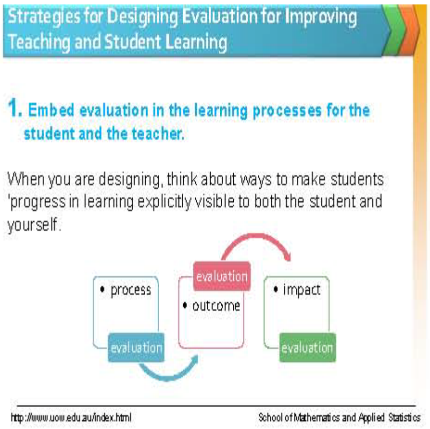

Produce
Produce your Camtasia Studio recording or project
Click Next to continue
Give your video a name & choose a location to save your produced video.
Camtasia Studio

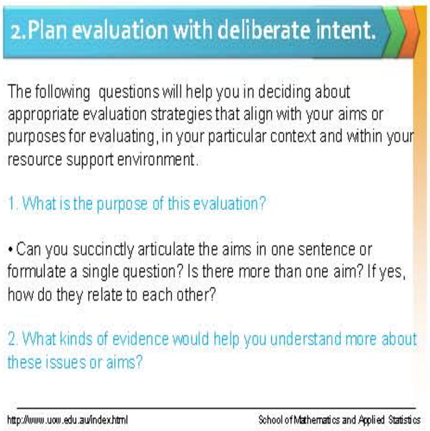

THE UNIVERSITY OF WOLLONGONG
AUSTRALIA
Thank you

Appendix 10:

Evidence based evaluation







2.Plan evaluation with deliberate intent.

3. What sources of information will you use?

• Where will you get this information? Who would have information about or a perspective on these concerns? Who are the audiences and stakeholders?

• What ethical issues and responsibilities need to be considered? Who owns and has access to data and reports?

4. What methods or approach will you take in collecting information?

• What kind of data or information do you want to collect? Why? Given the types of audiences and sources - what kind of strategies or methods will help to get appropriate and valuable information?

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5. What timeline would be best for undertaking each element of this evaluation plan?

• When is best? Why? Does timing matter for each of the different methods, tools, data and audiences or sources?

6. What resources and support do you have?

• What is needed? What is the most effective and efficient approach? Are the required resources available? If not, how does this impact on your plans and data collection?

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feedback and feed-forward what you learn from your evaluation.

After you have decided what you are going to take action on, think about who would benefit from hearing about the summary and outcomes

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Learning Design Evaluation form (ERF)

Agostinho et al. (2002) propose the use it:

- To review learning designs prior to implementation.
- To guide lecturers through the process of designing and planning learning to produce an effective learning design.

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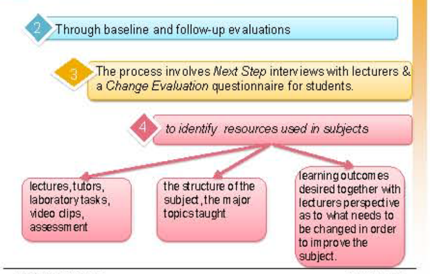
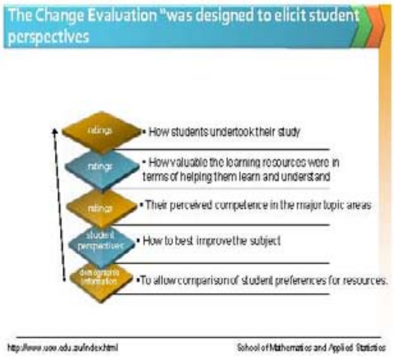
Porter (2007) describes a change evaluation process

Porter (2007) describes a change evaluation process



www.themegallery.com Company Logo


The Change Evaluation "was designed to elicit student perspectives
ratings
• How students undertook their study
ratings
• How valuable the learning resources were in terms of helping them learn and understand
ratings
• Their perceived competence in the major topic areas
student perspectives
• How to best improve the subject
demographic information
• To allow comparison of student preferences for resources.
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University of Wollongong
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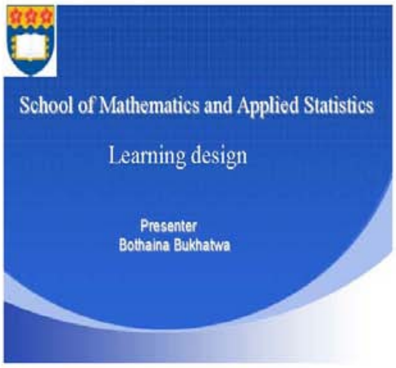
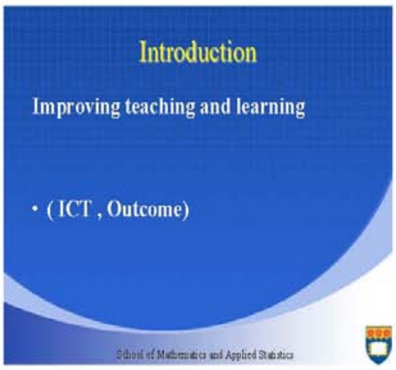
Appendix 11:

Learning design approaches






Learning design
• (Representation, exchange) teaching plan
• Higher model / course plan
• Learning (objective , activities)
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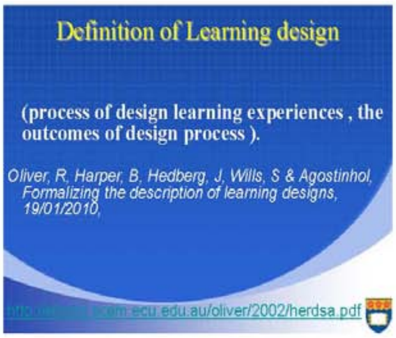
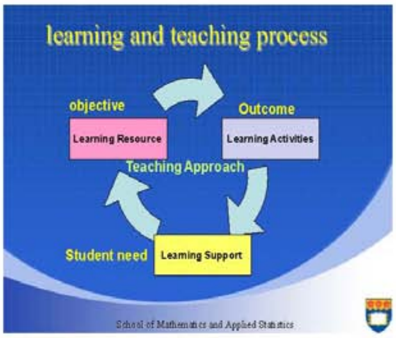

Definition of Learning design
(process of design learning experiences , the outcomes of design process).
Oliver, R, Harper, B, Hedberg, J, Wills, S & Agostinhol, Formalizing the description of learning designs, 19/01/2010,
ecu.edu.au/oliver/2002/herdsa.pdf


learning and teaching process
objective
Outcome
Learning Resource
Learning Activities
Teaching Approach
Student need
Learning Support
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Learning design
learning design as:
• framework for practice
• way to model and share practice
•technological infrastructure
Masterman, E, Jameson, J & Walker, S 2009, 'Capturing teachers'
design through case studies', Distance Education, vol 30, no 2
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Levels of learning design
1. a framework (outline ,activities , sharing) for practice
2. The technological infrastructure such as the "Learning Activity Management System" (LAMS), webcet, blogs.
3. learning design is a way to (model ,share practice) with a technology.
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other expressions
❖Educational design.
❖Instructional design.
❖ Curriculum/course design.
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The benefit of learning design

- What does learning design mean to me?
- Why it is important?
- Will my teaching change?

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Definition

- Communication structural model of an existing plane of the educational processes that support student to understand , to modify and to perform .

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Element of learning deign

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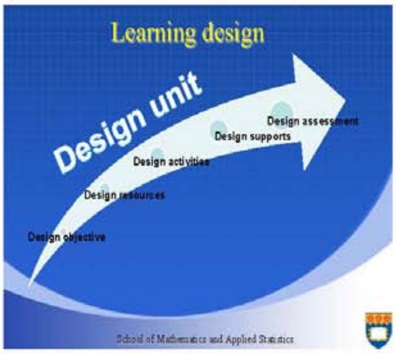
Learning design
Design unit
Design objective
Design resources
Design activities
Design supports
Design assessment
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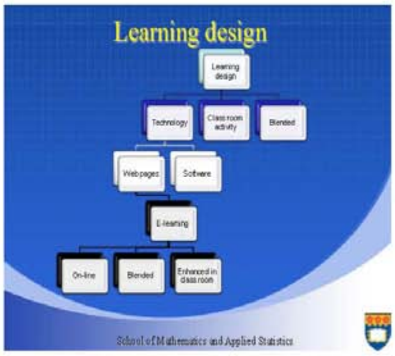
Learning design
Learning design
Technology
Class room activity
Blended
Webpages
Software
E-learning
On-line
Blended
Enhanced in class room
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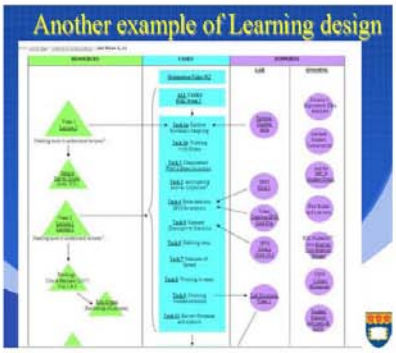
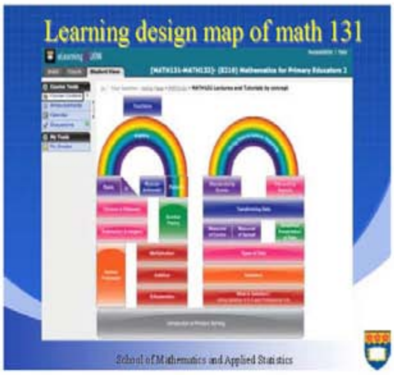

Another example of Learning design


Learning design map of math 131
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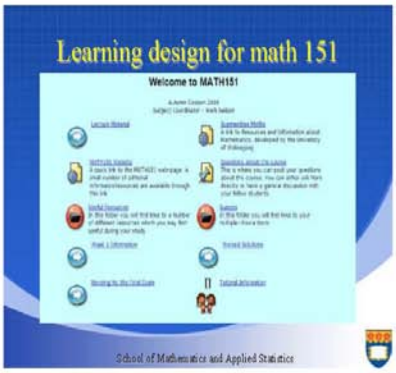
Learning design for math 151
Welcome to MATH151
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Learning design for math 151
WELCOME AT MATH 151
The Message for this week is ...
TRY TO BUILD YOUR ABILITY TO DO MATHS
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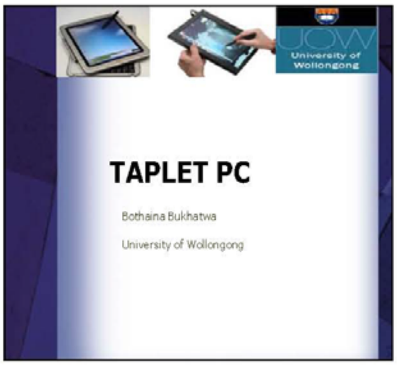
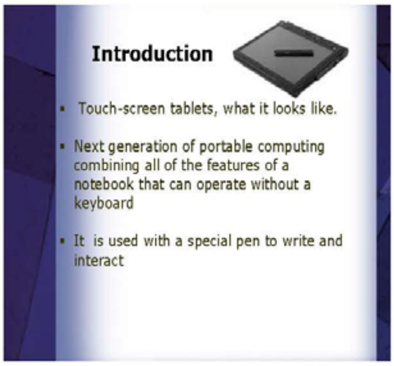
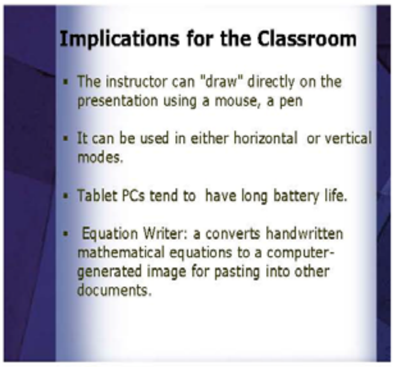
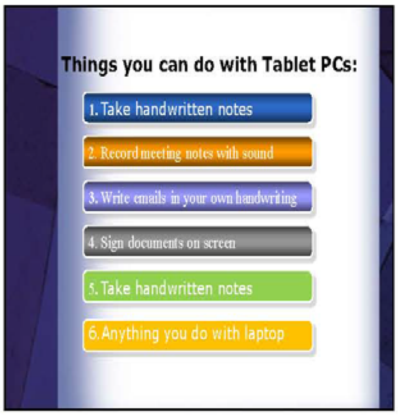
Appendix 12:

Tablet PC documentation



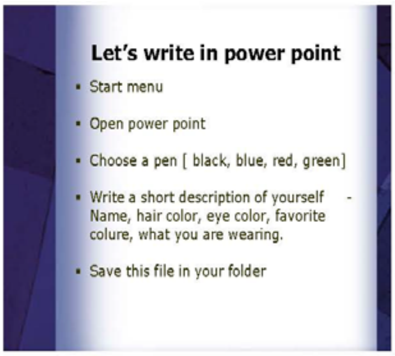


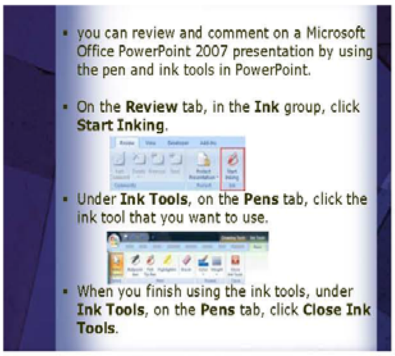


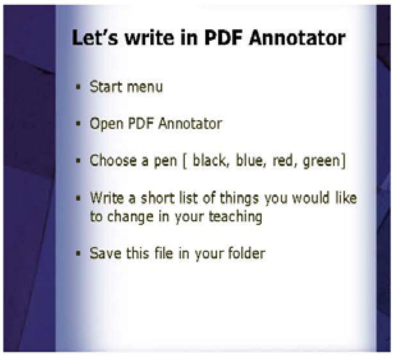

Things you can do with Tablet PCs:
1. Take handwritten notes
2. Record meeting notes with sound
3. Write emails in your own handwriting
4. Sign documents on screen
5. Take handwritten notes
6. Anything you do with laptop

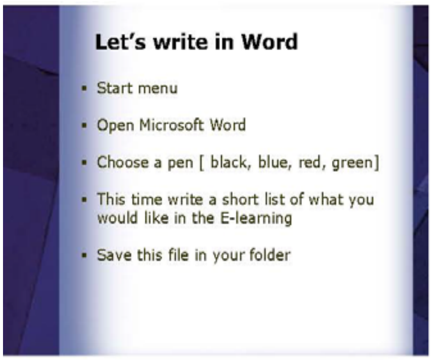

Inking
Power point
PDF annotator
Microsoft word
Windows Journal

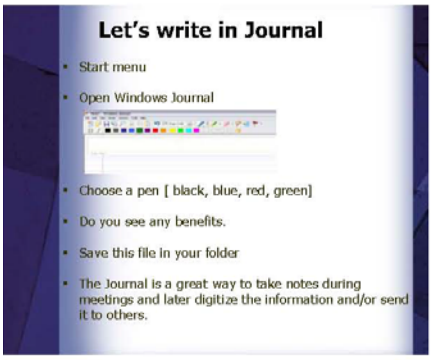

In the beginning
Use your styles to right click on a free space on your desktop
Select New
Select folder
Type your name
All work you do will be saved into this folder

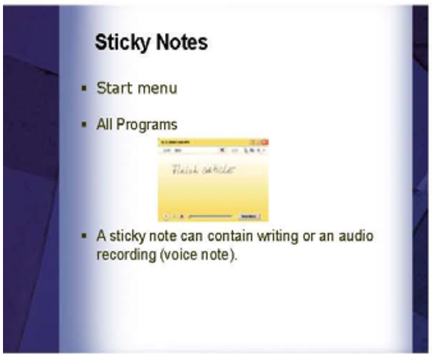

Let's write in power point
Start menu
Open power point
Choose a pen [black, blue, red, green]
Write a short description of yourself - Name, hair color, eye color, favorite colure, what you are wearing.
Save this file in your folder

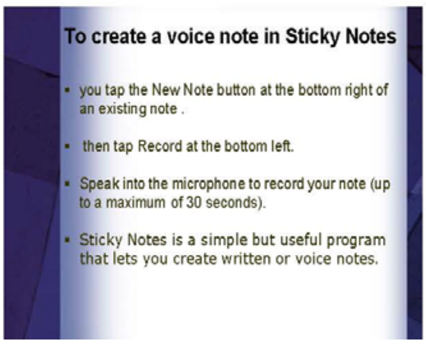

you can review and comment on a Microsoft Office PowerPoint 2007 presentation by using the pen and ink tools in PowerPoint.
On the Review tab, in the Ink group, click Start Inking.
Under Ink Tools, on the Pens tab, click the ink tool that you want to use.
When you finish using the ink tools, under Ink Tools, on the Pens tab, click Close Ink Tools.


Let's write in PDF Annotator
Start menu
Open PDF Annotator
Choose a pen [black, blue, red, green]
Write a short list of things you would like to change in your teaching
Save this file in your folder


Let's write in Word
Start menu
Open Microsoft Word
Choose a pen [black, blue, red, green]
This time write a short list of what you would like in the E-learning
Save this file in your folder


Let's write in Journal
Start menu
Open Windows Journal
Choose a pen [black, blue, red, green]
Do you see any benefits.
Save this file in your folder
The Journal is a great way to take notes during meetings and later digitize the information and/or send it to others.


Sticky Notes
Start menu
All Programs
A sticky note can contain writing or an audio recording (voice note).


To create a voice note in Sticky Notes
you tap the New Note button at the bottom right of an existing note .
then tap Record at the bottom left.
Speak into the microphone to record your note (up to a maximum of 30 seconds).
Sticky Notes is a simple but useful program that lets you create written or voice notes.