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An investigation into student and teacher perceptions of, and attitudes towards, the use of information communications technologies to support digital forms of summative performance assessment in the applied information technology and engineering studies courses in Western Australia

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An investigation into student and teacher perceptions of, and attitudes towards, the use of Information Communications Technologies to support digital forms of summative performance assessment in the Applied Information Technology and Engineering Studies courses in Western Australia.

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ABSTRACT

This study investigated the connections between teachers' and students' perceptions of, and attitudes towards, the use of Information and Communications Technologies (ICT) to support assessment in senior secondary courses in Western Australia, and the feasibility of such support in various forms. This investigation focused on the main characteristics of these perceptions, and attitudes and their relationships with curriculum, pedagogy, assessment and ICT. The findings provide guidelines for educators in using ICT to support summative performance assessment. My study was part of the main research study undertaken by Edith Cowan University (ECU) and the Curriculum Council of Western Australia (CCWA) and will provides significant clarity into the implementation of ICT support for performance assessment employing practices which characterise practical performance in digital forms. It was in the range of teacher and student perceptions and attitudes that this study added knowledge to the practice of digital forms of assessment.

The overall intent was to design, cultivate and implement the best assessment task possible to measure the practical performance of students in Engineering Studies and Applied Information Technology (AIT). Therefore, it was also necessary to evaluate the feasibility of this task and factors that would affect feasibility such as perceptions and attitudes of particpants. To achieve this the study needed to gather data in various forms from a wide variety of sources that would allow triangluation of data analysis. Qualitative data were gathered from a student survey where a set of measurements scales were constructed. Quantitative data were assembled from observation and discussion with teachers before, during and after schools' visits, from open-ended items in the student survey section and from teacher interview responses. In addition small groups of students were assembled into discussion forums and responses to a series of questions were recorded and analysed.

A number of critical thresholds had been reached to underpin the relevance and importance of research into aspects of the use of ICT to support summative assessment. Firstly the growth in access to, and improvements, in ICT services has enabled this emergent area of *digital assessment* or *e-assessment* (JISC, 2006). However, this growth is not sufficient justification for the investigation and implementation of digital forms of assessment. The research is justified when this growth in ICT is combined with the

increasing use of ICT to improve pedagogical practices; the employment of ICT to improve productivity in education; and the need to effectively and efficiently assess the practical performance of students in a large number of contexts. It was likely that the development of techniques to represent student performance in digital forms would assist the addressing of these imperatives. Whether these techniques were successful would depend on a number of influences including the attitudes and perceptions of students and teachers.

When accountability and efficiency are called upon comparisions are often made with non-ICT strategies. These controlled experiment approaches can prove problematic due to ethical and political questions arising with non-ICT groups. The inherent assumptions to computer use in exams contexts are still conducted using pen and paper. In addition their lack of or slow uptake of ICT and the believed that curriculum will remain unchanged despite the introduction of ICT to support. Therefore this study took an ethnographic, rather than experimental approach, but sought to make comparisons between two key stakeholders; teachers and students. In line with the larger study of which this study was a part, data were collected using observation, interview, survey and document analysis. Analysis and interpretation included the application of a feasibility framework and case study comparison. The adoption of the Concerns Based Adoption Model (CBAM) or models based upon CBAM as an instrument to analyse data was employed in the case studies. The feasibility framework comprised four interrelated and complex parameters Manageability, Technical, Functional and Pedgogical dimensions is described in chapter eight of this study.

It was evident from the research data, that students' and teachers' positive attutudes towards the computer-based performance exams and their beliefs in the value of ICT for assessment and all these intrinsic factors were fundamental to the feasibility of the implementation of digital forms of assessment in both Engineering Studies and AIT. From research data it was evident the application of ICT increasingly permeates students' and teachers' work and life, and their attitudes towards interaction with computer systems was a major factor in the success of digital forms of assessments in practical performance tasks. This was the focus and the background for this study.

This study found that students in both the Engineering studies and AIT case studies attempted the assessment tasks with enthusiasm, however the AIT assessments were perceived a little more positively by students and teachers than the Engineering studies

assessment. Assessment tasks worked best where the approach was familiar to students. This occurred for almost all cases in AIT, but not for Engineering although approach was relatively similar there were logisitical constraints in organising time to complete the tasks and in some cases technical in running the software on school workstations or accessing online systems through school networks. In a number of schools changes had to be mads to standard operating systems to allow software to run off USB thumb drives, video to be viewed, Flash applications to run within Internet browsers and sound to be recorded. Overall the study found that the benefits of digital forms of assessment implemented outweighted the constraints for both the Engineering studies and AIT course. In particular students' and teachers' responses were overwhelmingly postive due to the practical nature of the work in all assessment tasks. Generally they perferred this form of assessment to paper-based assessments.

This study has added to existing knowledge on the implementing of digital forms of assessment, in particular to both the Engineering Studies and AIT, and in general to secondary senior courses in Western Australian (WA) schools.

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TABLE OF CONTENTS

xiii

List of Tables

List of Figures

CHAPTER ONE:
INTRODUCTION

This study conducted research into the application of digital forms of assessment as a key element of educational reform in senior secondary courses in Western Australia (WA). This study focused on the students' and teachers' perceptions of, and attitudes towards, the employment of Information Communication Technology (ICT) to support authentic assessment of performance. This chapter introduces the study by providing a background, introducing a rationale, explaining its significance, making a statement of the problem and its research questions, and defining the terms utilised and the acronyms that represent some of them.

This study was part of a larger research study undertaken by Edith Cowan University (ECU) and the Curriculum Council of Western Australia (CCWA), which investigated the implementation of ICT support for assessment of practical performance through techniques to represent this performance in digital forms. The researcher was not a chief investigator in the larger study but was involved as a member of the research team during 2008. The research within this study sought to build on, and be aligned with, a component of the larger research project, known as the *Digital Forms of Assessment Project,* conducted by the Centre for Schooling and Learning Technologies (CSaLT, 2011), and supported by an Australian Research Council (ARC) linkage grant. It is in the area of student and teacher perceptions and attitudes that the present study adds knowledge to the use of ICT to support performance assessment. This study focussed on the attitudes and perceptions of students and teachers in using ICT for learning, and the effect on its use to support high-stakes summative performance assessment in senior secondary courses that incorporate different types of practical performance.

Background to the Study

I It is useful initially to briefly consider the present situation concerning the use of ICT in Australian schools. In doing so, it is necessary to consider the ICT skills and knowledge students require in their acquisition of twelve years of schooling. It is cruical for schools to ensure that teachers have the attitudes and perceptions conducive to achieving these skills and knowledge. It is claimed that today's students are digital natives; they are switched on to a highly interconnected, networked digital universe (Prensky, 2001). They increasingly use

17

powerful tools to play, communicate, share support learning and solve problems. Does this mean these technologies should be employed in all aspects of teaching, including assessment?

As discussed in the report '*Selected higher education statistics: Students 1999*' (DETYA, 2000) advanced digital technologies are customised to different uses which have been progressively infused into work and life. This has impacted public administration and finance to all sectors of industry, media, communications and leisure. It is perceived that students in Australian schools will need to be able to work and live in environments requiring competency in the usage of digital technology (MCEECDYA, 2011). Additionally, they will need the ability to adapt their skills, and understanding and respond to change. It seems obvious students need to be able to obtain information from various sources, such as parents, teachers, books, television and the Internet, and then process information in various ways, with and without technological support, and finally communicate that information to others in a variety of forms, including written, verbal, and multimedia presentations. In processing information in this way students develop knowledge and skills transcending specific curriculum areas. Schooling needs to adapt to this change in output requirements while continuing to respond to the diverse range of learners.

From the 1990s, substantial improvements in computer technologies have been the arrival of low cost, high power portable computers, and improvements in the operation of computer networks, and the accessibility of the Internet. These technologies have appeared in schools at an escalating rate with an expectation they would be employed in teaching and learning processes to provide improved outcomes for students (Redecker & Johannessen, 2013, p. 79). During the same period school systems in Australia had been moving towards a more standardised curriculum wherein student capability was important and therefore they had been exploring ways of assessing students efficiently and effectively from this perspective.

There has been a widening of the choice of tertiary entrance pathways and subjects offered to students; and a rationalising of course structures, evaluation practices and subject selection criteria in senior secondary education in W.A. (SCSA, 2015a). Many new courses included substantial practical performance components requiring, for example, the designing and making of physical products, physical movement or creating materials on computers. However, when assessment of skills and knowledge was made, pen and paper testing was still the predominant form. What was needed for courses like Applied Information Technology (AIT) and Engineering Studies was the provision of appropriate digital learning technologies

in the teaching, learning and assessing of practical performance components, for example, digital portfolios and computerised examinations (SCSA, 2015a). Within the school system of Western Australia high-stakes, summative assessment in the Engineering Studies and AIT courses were, and are still, being measured by traditional assessment methods using pen and paper. This is a critical problem with such courses having large practical performance components. Linn et al. (1991, p. 15) would suggest that "there was an expectation from students and the general community that assessment of student performance would reflect the nature of this learning". Therefore, as the application of ICT increasingly permeates students' and teachers' work and life, and their attitudes towards interaction with computer systems is likely to be a major factor in the success, or otherwise, of digital forms of assessments in practical performance tasks . This was the focus and the background for this study.

While the deployment of ICT in schools and universities in Australia has become increasingly pervasive it has tended to have little impact on approaches to assessment. As Gipps (2005) states "in universities, the use of ICT in learning and teaching was much further advanced, while the use of ICT to support assessment was more patchy" (p. 172). For example, educational researchers (Lin & Dwyer, 2006; Pellegrino et al., 2001) argue that traditional assessment only measures knowledge of basic facts and procedures but fails to assess learning processes and such higher order thinking as decision-making, reflection, reasoning and problem solving. For the teacher, the marking, reporting and managing assessments have been hardly affected by the growing access to ICT (Redecker, 2013). In other words, the application of ICT to the student and teacher aspects of assessment is still in its infancy, especially where professional judgment of performance was involved. In Western Australia this became critical with the development and implementation of the new high stakes senior secondary courses, many of which claimed to encourage a broader range of performance.

The New Courses of Study

Over the past two decades educators and the broader education community, have demanded the better accommodation of the diverse learning needs, interests and aspirations of students. This was reflected in WA in the creation of 50 new senior secondary courses from 2006 to 2009 designed to meet better the needs of the range of students now required to remain at school. The changes arose from a review of post-compulsory schooling, later to be renamed Senior Schooling that identified the need for greater alignment between senior secondary

education and the Kindergarten to Year 10 curriculum. Engineering Studies and Applied Information Technology were two of the new courses.

These two courses were introduced in 2007 with the syllabus and assessment process updated in June 2013 SCSA (2015c, p. 8). The Western Australian Certificate of Education (WACE) manual contains essential information on assessment, moderation and examinations needed to be read in conjunction with these courses. WACE is given to students who have completed Year 11 and 12 of their secondary schooling in W.A. and is part of the Australian Qualifications Framework. The focus of assessment in general for these two courses was determined in part by the context of learning, for example, "students may call upon a full range of 21st century learning technologies to research, collate and present knowledge, to design solutions and to solve problems". Each of these two courses consists of an external and a school-based assessment. The roles of school-based and external assessment were significant as a moderation process in determining students' grades. Furthermore, these courses included substantial practical performance components requiring a means of providing accurate and authentic assessment that adequately responds to the conceptual underpinnings of skills, knowledge and understandings inherent in practical performances (Thorburn, 2007). This is illustrated with the following quotes from SCSA (2015c, p. 6) the School Curriculum and Standards SCSA (2013, p. 6).

> *These technologies are increasingly becoming part of everything we do within a knowledge-based society, built around the innovative, creative and enterprising use of ICT to improve the standard of living. All Australians need to possess and be empowered by understanding, experience and skills in the nature and use of ICT.*

However, the types of assessment for both AIT and Engineering Studies consisted of Investigation, Production/Performance and Response; with all these predominately pen and paper-based, including a three-hour written examination at the completion of the course.

Applied Information Technology course

For the AIT course digital technologies provide the content for study as well as pedagogical support (Newhouse 2010). The intention of the course is for students to spend the majority of their time in class using digital technologies to develop information solutions. In the current assessment structure, the proportion of credit arising from a student's schoolwork and the external examination is allocated equally (SCSA, 2015c). The syllabus stipulated around 50%

of the weighting of assessment to be on production, 30-40% on investigation, and 10-20% on response. Clearly, the course intended the majority of credit to be earned in some practical activity. However, in the external examination credit is earned from answering questions on paper comprising multiple-choice, short answer and extended answer questions with the resulting score being used to moderate the school score. This negated the balance of assessment between practice and theory, and did not reflect the intention of a practical course (SCSA, 2015c, p. 8). The course was designed for students to focus on and be motivated by the practical performance components.

However, most AIT teachers believe the practical nature of the AIT course provides them with the opportunity to employ digital technologies in capturing abstract knowledge of the design process, design principles and conventions. Which includes any assessment of students' practical capability or application of theory to complex problems. They believe the use of ICT in assessment could minimise the marginalisation of practical skills, this being the primary reason for the existence of the course. This was evident from responses from post-teacher interviews from this study, and concurring with (Lane, 2004) with regard to eliciting complex cognitive thinking.

Engineering Studies Course

The Engineering Studies course was designed to provide students with a focus on design through creative, practical and relevant opportunities for them to investigate, research and present information, design and make products, and undertake project development. The intention was that these activities would "provide students with opportunities to apply engineering processes, understand underpinning scientific and mathematical principles, develop engineering technology skills, and to understand the interrelationships between engineering projects and society" (SCSA, 2015c, p. 3). Engineering Studies was essentially a practical course focusing on real life contexts. It aimed to prepare students for a future in an increasingly technological world by providing the foundation for life-long learning about engineering (SCSA, 2015a, p. 3). It was particularly suited to those students who were interested in engineering and technical industries as future careers.

The course content was sequential and hierarchical in nature, increasing in complexity as further units (1-3) were studied. The course outcomes composed of four components: Engineering Process, Engineering Understandings, Engineering Technology Skill, and

Engineering in Society. Three types of assessment are stated for the Engineering Studies course: investigation, production, and response. That is students investigate needs, opportunities and problems that are defined in "a *design* weighted between 20-30%; document the design specifications in the *production* phase between 50-60%, and apply knowledge and skills in their response phase between 20-30%" (SCSA, 2015a, p. 8). When it comes to the external assessment, the assessment largely required students to write what they can remember of a body of content. Consequently the external asseessment is not only misaligned with the intended curriculum, but also with societal requirements.

The Digital Forms of Assessment Project

The present study was a component of a larger project and thus a brief introduction is now provided to this project. The Digital Forms of Assessment project was a three-year study (2008-2011) conducted at the Centre for Schooling and Learning Technologies (CSaLT) at Edith Cowan University (ECU) in collaboration with the Curriculum Council, currently known as the School Curriculum and Standards Authority of Western Australia and supported by an Australian Research Council (ARC) Linkage research grant (Newhouse 2013). The project concerned the potential to employ digital technologies to represent the output from assessment tasks in four senior secondary courses, *Applied Information Technology* (AIT), *Engineering Studies, Italian Studies*, and *Physical Education Studies* (PES). The project focused on the employment of digital technologies to 'capture' performance on practical tasks for the purpose of high stakes summative assessment. The purpose was to explore this potential so that such performances could be included to greater extent in the assessment of senior secondary courses in order to increase the authenticity of the assessment in these courses. The study involved case studies for the four courses involved. During the three years the study a total of 82 teachers and 1015 students were involved, the number of students involved in each case study ranging from 2 to 45.

Four different fundamental forms of assessment namely, reflective portfolios, extended production exams, performance tasks exams, and oral presentations; were investigated in 81 cases with related students and with the assessment task being different in each course. For each case, a variety of quantitative and qualitative data were collected from students and teachers involved, including digital representation of the students' work on the assessment tasks, surveys and interviews. These data were analysed and used to address the project's research questions within the feasibility framework, consisting of four dimensions:

Manageability, Functional, Technical, and *Pedagogy.* The present study formed a component in the second year of this major study.

Purpose/Aims of Study

The aim of the present study was to investigate the perceptions and attitudes of students and teachers as they became involved in employing ICT to support high-stakes summative performance assessments. The view concerned the use of new technologies to develop alternative assessment methods, that are demonstrably valid, fair and comprehensive; and will allow examining authorities to assess students in a realistic and educative fashion. This would allow improvements in the quality of assessment students are set in courses such as AIT and Engineering Studies. However, the success of this approach would depend partly on the attitudes and perceptions of students and teachers. Thus the investigation focused on the nature of student and teacher attitudes and perceptions towards digital forms of summative assessment in the two courses.

Perspectives on the relationships between ICT and the assessment of practical components in such courses (AIT and Engineering Studies) required attention, for appropriate assessment. While the use of some digitally based forms in assessment had been implemented to some extent in other parts of Australia and overseas, this had not been done in Western Australia. Additionally little comparative research internationally had been finalised into the variety of digitally based forms of assessment that may be considered. Further, it was important such research be conducted within typical school-based settings to reflect the realities of students. This study sought to conduct an in-depth exploration of the attitudes and perceptions towards forms of digitally based assessments in two very different courses with the view of expanding this to be applicable to a range of courses. Such assessment requires 'process' evidence such as emerging ideas, and the means by which they are developed and detailed (Curriculum SCSA, 2015b, p. 4).

Rationale for Study

Reform is a constant part of the educational landscape; the details change frequently. Even the guiding philosophies and major themes may change from one reform to the next. At times a new reform involves a major shift or pendulum swing as one ideological camp gains ascendance over another. Assessment and accountability have played prominent roles in many

of the reform efforts during the last 50 years. Thus assessment has been both the focus of controversy and the darling of policymakers (Kimbell, 2012; Kimbell & Pollitt, 2008).

Currently there has been a move away from objective assessment tasks, usually involving *shallow* learning, towards more authentic, educative, subjective and higher order thinking assessment tasks involving *deep* learning (Briggs, 1999; Brown & Glasner, 1999; Gibbs & Simpson, 2004). At the same time, the requirements and demands for authenticity, accountability, reliability, validity and transparency in the assessment process have been increasing for all stakeholders. The actual practice and achievement of these changes, requirements and demands have been difficult and limited, as the following quote from Gibbs and Simpson (2004, p. 11) indicates: "*Assessment sometimes appears to be, at one and the same time, enormously expensive, disliked by both students and teachers, and largely ineffective in supporting learning*".

The employment of ICT in schools in Australia, as for many other countries, has changed greatly over the past 20 years at all levels of education, and in many areas of operation including administration, teaching, learning and assessment. The driving forces for these changes have been both internal and external, and included factors, such as, policy decision making, pedagogical practices and authentic performance assessments. During the same time many changes in policies have occurred encouraging more students to stay at school longer, tailoring courses to the needs of less academically inclined students, and considering changes in the work and life requirements of modern citizens. Increasingly in schools students might call upon a full range of 21st century ICT to research, collate and present knowledge, to design solutions and to solve problems. However, for scholastic assessment, access to the same tools was usually denied, pen and paper testing remaining the predominant form. This was especially so in the specific area of task assessment involving practical performances in W.A. senior secondary courses such as AIT and Engineering Studies.

As ICT has became more widely deployed in classrooms and schools, attention has been focused on how ICT could support assessment and the need to investigate alternative forms of assessment which are valid, reliable and verifiable in practical performance-based courses. It was evident from the body of literature that traditional assessment methods were failing to assess adequately student performance in courses with a large practical component. Some education leaders believed it to be inevitable that that the use the employment of ICT to support assessment of student performance, including the high-stakes end of Year 12

examinations, "will be conducted online in the near future, perhaps within the next five to eight years" (Wood, 2008, p. 19). For some courses this change might be due to the cost of other forms of assessment, in others the nature of expected student performance might have changed and therefore not be suited by traditional assessment methods, while in others the nature of the curriculum may require the employment of ICT. Examples of all three types of courses were found in the technology curriculum that had evolved in Australia over the last thirty years.

The use and application of ICT in education has been one of the major changes occurring in the recent past in teaching and learning in Australian schools and universities, and is continuing to expand rapidly. Although this change had markedly affected teaching and learning for both teachers and students, assessment had been least affected (Gipps, 2005). However, as explained earlier, there has been increased interest and research in this area over the past decade, including a ground-breaking project in the United Kingdom (UK) titled e-Scape. The e-Scape project which was aimed at utilising ICT to support better performance assessment, was conducted by the Technology Education Research Unit (TERU) at Goldsmiths College, University of London (Kimbell et al., 2007). This project built upon many years of work on improving assessment in the design and technology curriculum, but has recently expanded to include other areas of the curriculum. e-Scape combines three innovations in the assessment of practical performance by representing student work entirely in digital form, collating this work using an online repository, and marking it using a comparative pairs judgments technique. Following a similar approach, CSaLT at ECU conducted a pilot study on the potential to use digital technologies to represent the output from assessment tasks in two senior secondary courses, AIT and Engineering Studies.

These two courses had substantial practical performance components requiring students to demonstrate the technology process in designing and making physical products, physical movement, or creating materials on computers. These forms of scholastic skills and knowledge could only be reflected validly and meaningfully with ICT supporting the assessments. Assessments of performances in practical courses such as these cannot be tested by traditional paper-based assessments, were inevitably compromised.

WA has a history of performance-based assessment in some secondary school courses in the Arts. However, the use of performance-based assessment in high stakes secondary courses had been limited by the costs involved in collecting the evidence of performance, and

difficulties in ensuring reliable and valid results. This provided a rationale for the employment of digital technologies to support such assessment. Research was required to investigate this potential and determine appropriate forms of ICT support and implementation techniques and conditions. In this situation the perceptions and attitudes of teachers and students was critical.

Growing awareness and acknowledgement had taken place among educators, policymakers, and others who had interest in the influence assessment has on curriculum (Kimbell, 2004). Freeman and Lewis (1998) described assessment as "one of the most effective ways of changing how and what students learn" (p. 4). This takes places where the *backwash* effect of assessment is positive, that is, when assessment is aligned to the curriculum (Bone, 1999). Educators are turning to alternative assessment tasks or methods as a tool for achieving educational reform (Biggs, 1999); they realise changes to the assessment process are needed to reform curricula and instruction. However, "assessment is still under-discussed and, in most disciplines, an under-researched aspect of education" Boud (2010, p. 1). Changes to assessment involving the employment of ICT are intended to take into consideration the learning environment, and particularly the perceptions and attitudes of teachers and students.

Significance of the Study

This study was significant for several reasons to be outlined in this section; it has implications for the development of digital forms of assessment, particular highstakes for summative purpose. Recent literature attests to the claim traditional assessment methods fail to assess the learning process itself adequately, and higher thinking skills in particular (Lin & Dwyer, 2006; Pellegrino et al., 2001). Researchers have shown the significance of the knowledge about attitudes and perceptions towards ICT in assessing higher order thinking skills (Masters, 2013; Pierce et al., 2013; Redecker & Johannessen, 2013). This trend has also highlighted the shortcomings of the current assessment processes and practices with regard to attitudes and perceptions towards the application and deployment of ICT in teaching and learning. Research has shown that students engage better with subject matter when it is connected to their expectations about how their achievement will be evaluated (Elton & Johnston, 1999). Educators who strive to bring authentic learning experiences to their students must devise appropriate and meaningful measures to assess student learning and mastery of concepts at hand. Masters (2014) contends that student and teacher attitudes and perceptions towards the use of ICT and assessment are crucial to the assessment of authentic learning

initiatives. This concurred with Elton and Johnston (1999) when they suggested there are, numerous examples pointing to the opportunities available for effective assessment of authentic learning initiatives, but that there are barriers to overcome.

Currently, when scholastic assessment of skills and knowledge is made, pen and paper testing is still the predominant form and this lacks validity for the assessment of performances that are practical in nature, It is self-evident that assessment of a course of study in which students learn with and through new technologies, should allow students to use those technologies in the assessment process. Further, suggestions have been made that 'skills in ICT are essential for much of modern living, and so should be a target for assessment' (Elton & Johnston, 1999). An awareness existed within the Curriculum Council that many of the new senior secondary courses included substantial practical performance components requiring the development of authentic and reliable assessment of performance to replace traditional paper-based exams so that the courses did not become predominantly theoretical (Ridgway et al., 2006). The comments of Wood (2008) provide significant benefit in terms of the national priority to achieve nationally consistent curricula with greater accountability to common standards in senior schooling. This provides a national imperative to develop rigorous, reliable and viable forms of performance assessment.

The study had both a national and local significance. In particular, at the local level with the development of the new senior secondary courses in WA that purport to be more relevant to a diverse range of students. It was considered that a range of forms of assessment match performance requirements. This needed to be achieved in a highly reliable and verifiable manner without excessive costs being incurred. With students increasingly using ICT within their normal learning activities there was a strong rationale to investigate the potential of digital technologies to support these alternative forms of assessment. For this to be feasible, consideration was needed of the attitudes and perceptions of teachers and students towards these approaches to summative assessment. This was the area of concern upon which the present study focused. It was in this area that this study added knowledge to the use of ICT to support digital forms of assessment by a comparative study concerning the Engineering Studies and AIT courses in WA schools.

Statement of Problem

The assessment of student performance in areas such as Engineering Studies and AIT, does not lend itself to traditional, paper-based testing methods. In these courses, much emphasis is placed on the acquisition and demonstration of practical skills but these may be difficult, if not impossible to measure on theoretical, written assessments. Alternative assessment practices, which are both valid and reliable, need to be devised for the practical aspects of these courses. The capture in digital forms of students' work may allow the development of more authentic forms of summative, high-stakes assessment with high reliability. For example, digital forms of assessment might be students working with the application of productivity software on computer, video recordings, audio recordings, or photographs of performances, or scanned work. The implementation of digital forms of assessment into both the Engineering Studies and AIT courses will not be successful if no account is taken of the attutudes and perceptions of the participants, that is principally students and teachers of these two courses. Key stakeholders, that is students' and teachers' attitudes towards and perceptions of assessment are significant to successful implementation of assessment practices. Students and teachers are currently living in an era of accelerating change. Their attitudes and perceptions are likely to be influenced by the nature of these changes, which is imperative to society as a whole, and in particular assessment for learning; "ICT is increasingly seen as a vehicle for authentic digital forms assessment for the 21st century competencies for lifelong learning" (Masters, 2013, p. 27). What needs to be done is to ensure that ICT advances support and foster pedagogical innovation, perhaps by "modelling upon current ICT-enabled assessment practices with particular focus on and develop confidence and satisfaction in the use digital forms of assessment" (Redecker & Johannessen, 2013, p. 80). Therefore the success of the implementation of digital forms of assessment is directly linked to their beliefs in the efficacy of the assessment.

Research Questions

The main research question for this study was:

In what ways do the perceptions and attitudes of teachers and students towards the use of ICT in learning affect the feasibility of using digitally based representations of student work output on authentic tasks to support summative performance assessments for the Engineering Studies and AIT WA courses?

The present study was conducted within the context of the main study that investigated the feasibility of implementation of digital forms of assessment in both Engineering Studies and the AIT courses. These new approaches to assessment need students and teachers to determine whether or not they are advantageous or effective. Consequently, a number of subsidiary questions were addressed:

*(1)	What are the attitudes and perceptions of teachers towards the use of digital forms of performance summative assessment?*

*(2)	What similarities and differences occur in student and teacher perceptions and attitudes towards ICT in assessment in AIT and Engineering Studies?*

*(3)	What effects on the feasibility of digital forms of assessment do student and teacher attitudes and perceptions in AIT and Engineering Studies have?*

Definition of Terms

Digital representations of student performances: electronic files of students' work recorded as video, photographs, audio, text and/or graphics.

Extended Production Examination: a task completed under examination conditions, incorporating a full range of processes, providing a holistic process of the design, creation and appraisal of a product.

Focused performance task: a practical task completed under examination conditions and submitted in digital format.

Reflective process portfolio: a collection, in digital form and according to a predetermined structure and sequence, of the work output *during* the completion of a task. Files might include; initial ideas, design sketches, reflective commentary, video and photographs.

Recorded interview: a video or audio recording of the student's responses to a series of scripted questions and prompts designed to elicit the thinking processes connected with completion of a task.

Manageability of digital form of assessment: pertaining to the practicalities of administration, collection and assessment of artefacts of student work in digital forms.

Technical facility of digital form of assessment: concerning the extent to which existing technologies are suitable for adaptation to the purposes of assessment.

Pedagogy of digital form of assessment: pertaining to the extent to which digital forms of assessment can support and enhance teaching and learning

Functionality of digital form of assessment: concerning the validity and reliability of digital forms of assessment and their comparability with other methods of assessment.

The definitions of *Attitude* and *Perception* used in the study are taken from Hornby (1997), who defined 'Attitude' as 'a settled way of thinking or feeling about something' (Attitude), and 'Perception' as 'the way which something is regarded, understood or interpreted' (Perception).

Acronyms Used

ACARA: Australian Curriculum Assessent and Reporting Authority

AIT: Applied Information Technology

ARC: Australian Research Council

BECTA: British Educational Commucication and Technology Agency

CAA: Computer-Automated Assessment

CBAM: Coccerns-Based Adoption Model

CAD: Computer-Aided Design

CAS: Computer-Supported Assessment

CBT: Computer-Based Assessment

CSaLT: Centre for Schooling and Learning Technologies

CRT: Criterion Referenced Testing

CSHE: Centre for the Study of Higher Edcuation

DoE: Department of Education WA

D&T: Design and Technology

DVD: Digital Video (Versatile) Disk

ECU: Edith Cowan University

ESL: English as a Second Language

ETS: Educational Testing Services

EYLF: The Early Years Learing Framework for Australia

GB: Giga Byte

HTML: Hypertext Mark-up Language

IC: Innovation Configuration

LAN: Local Area Network

LoU: Level of Use

MCEECDYA: Ministerial Council for Education, Early Childhood Development and Youth Affairs

MB: Mega Byte

MS: Microsoft

NCTM: National Council of Teachers of Mathematics

NRT: Norm-Referenced Testing

OECD: Organisation for Economic Cooperation and Development

OLA*: On-line Assessment*

PDF: Portable Document Format

PES: Physical Education Studies

PHP: General purpose scripting language for dynamic webpages

SoC: Stages of Concern

SD: Standard Deviation

SPSS: Statistical Package for the Social Sciences

SQL: Structured Query Language

TPACK: Technology Pedagogical Content Knowledge

USB: Universal Serial Bus

WACE: Western Australian Certificate of Education

Conclusion

This thesis consists of eight chapters, Chapter 1 has introduced the problem, presented a rationale for the study, provided an overview, and listed the research questions. Chapter Two, *Review of Literature,* reflects on the narrative related to the study, starting from the perspective of assessment in its broadest sense. This then leads on through the use of digital forms of assessment and guides specific to students' and teachers' attitudes and perceptions towards answering the research question which links into the conceptual framework of the study. Chapter Three, *Method,* describes the research design, data collection and data analysis to be undertaken. Chapter Four, *Data Analysis*, brings together, summarises and examines the data from all sources. Chapters Five, and Six *Case Studies,* detail the cases on the bases of data analysis, results and conclusions specific to each of the ten participating schools. Chapter Seven, *Discussion of Results,* reviews the results in light of the research questions, pointing out constraints and benefits according to the four dimensions of Manageability, Technical facility, Functionality and Pedagogy. Chapter Eight, *Conclusions*, draws out the evidence-based findings derived from this study, makes recommendations for the implementation of digital forms of assessment, and points to future directions in the use of digital technologies in assessment, learning and teaching.

CHAPTER TWO:
LITERATURE REVIEW

This chapter provides a summary of the literature reviewed to develop a theoretical framework and research design. Three distinct and major fields, *Performance Assessment, Computer-Supported Assessment and Human-Computer-Interaction* were significant to reflect in a review of the current literature for developing a theoretical framework to inform this study. In particular, this culminates in student and teacher perceptions of, and attitudes towards, the deployment of ICT to support digital forms of summative performance assessment.

The study built upon earlier research concerning the characteristics of students' and teachers' perceptions of and attitudes towards the employment of ICT to improve teaching and learning in general, and applied this to performance assessment in particular, from the British Impact Study (BECTA, 2003). This report addressed the question of contribution of ICT to students' learning. For example, like many other educational reports pointed to the findings that ICT had a highly positive impact on children's achievement, shown the complexities involved in a similar comprehensive longitudinal studies. These studies with similar aims have revealed problems such as a tendency to ask what (Papert, 1985) refers to as 'techno-centric' questions.

Doubtless, the significance and consequences of assessment of what students concern as imperative, and how they view their performance/achievement, are all determined by the nature of their assessment Papert (1985). Sometimes the reality of assessment does not match the preferred pedagogy and learning outcomes perceived by students. However, the fact remains, what is taught is what is assessed, the latter bearing little resemblance to the learning requirements (McGaw, 2009; Newhouse, 2010). What is assessed is reflected by what is easily be shown on paper using a pen, in a short time (Ridgway et al., 2006).

Today, although digital technologies has infused most aspects of modern-day life, including schooling and beyond has been required of education systems in terms of results and input, procedures of summative assessment have altered little and are genuinely out of alignment with curriculum, pedagogics and the needs of the individual (Clarke-Midura & Dede, 2010). In today's ecconomy enterprising, innovation and information sharing are increasing in consequence as more routine work processes are increasingly performed by technology (Clarke-Midura & Dede, 2010). Thus, the advent of new digital technologies will undoubtly necessitate entirely new skills and ways of communicating and sharing information. These

learning outcomes are now being identified by literature in educational strategy documents as fundamental objectives of education in the 21st century. The general perception is notwithstanding the challenges in measuring many of the competencies now being identified as important, "it is clear that most traditional assessment methods are inadequate for this task" (Lane, 2004, pp. v-vi). Assessment of competencies-based course dilemmas remain largely unresolved as in the case of perfoemance outcomes-based assessment for both Engineering Studies and AIT courses. They are still being assessed on paper using a pen, in spite of the recognition of the lack of alignment and authenticity noted in current literature (Masters, 2013; Newhouse, 2010). As discussed in the some literature, currently progress is underway in new methods of assessments, including through the international Assessment and Teaching of 21st Century Skills project (Griffin et al., 2012).

The present study was concerned with students' and teachers' attitudes and perceptions towards employing ICT with summative assessment to measure a set of skills and knowledge. This study drew from three main fields of research: performance assessment, computer-supported assessment, and human-computer interaction (Newhouse, 2013). Although these fields are subsumed within the general field of assessment, they have significance relevant to the discussion of attitudes and perceptions of performance because they are at the heart of interplay between assessment, technology and users. The following sections will discuss the connection and the interplay of these three fields relative to students' and teachers' attitudes and perceptions about the use of ICT-supported assessments investigated by the study.

Performance Assessment

This section discusses the importance, purpose and types of performance assessment, and how these relate to the nature and alignment of pedagogical practices in supporting practical learning activities. As Darling-Hammond (2004, p. 7) stated, "Performance assessments are often referred to as realistic problems or authentic tasks, reflecting the intention to have students solve real world problems in true-to-life contexts". In order to understand the efficacy of performance assessment, a grounding in the nature and purpose of assessment in general, is necessary.

In performance assessment, students are require to accomplish a task rather than selecting among predetermined choices, students must either construct or source a solution, construct a product, or perform an activity. From this view, performance appraisal involves a very wide-

ranging of activities, from playing a sport to producing a product. Other examples may be completing a short answer sentence, to literature analysis in essay form, to conducting a laboratory investigation, and writing a hands-on descriptive analysis of the process.

Why is assessment important?

To be able to understand the reason for assessment being important, and to make the connection with the following sections consideration must be given to:

- the nature of pedagogy and content;

- alignment between intended content and pedagogical practices;

- how assessment supports student-learning;

- how assessment identifies growth in learning;

- how assessment provides motivation; and

- how assessment provides a basis for selection and certification.

The nature of pedagogy and content

The significance and consequence of assessment is clear, as (Madaus & O'Dwyer, 1999) state, "assessment is at the heart of student experience" (p. 11). More recently, Masters (2013, p. 4) provides the rationale for assessment policy and practice, explaining that "people learn drawing on insights from developmental psychology, cognitive science and neuroscience". He argues that a focus has emerged on evidence-based practice in education as a result of these new understandings of the nature of learning. He further explains "that the purpose of assessment is to establish where learners are in their learning, and to collect evidence of their learning". That is, good pedagogy requires assessment to provide evidence based on an empathetic nature of learning and the content to be learned.

Today, calls for improved evidence to inform decision-making required different beliefs on scholastic assessment. According to Masters (2013, p. 3) "it is not to judge as to understand about student growth". Traditional expectations of evaluation were founded on a belief that the role of teachers was to deliver the curriculum. For example, the role of students was to learn; and the role of assessment was to establish how much of what teachers had taught, students had successfully learnt. However Masters (2013, p. 30) believes learning to be "an ongoing, potentially lifelong process; within any given area of learning, and at any time, every

learner is at some identifiable point in their long-term learning, and having the capacity further progress". This is a transformation from the age-based, lock-step of pedagogical practices to one dedicated on the "developmental needs of every learner derived from evidence gathering and reflection with respect to empirically based learning progressions.

In addition, Kozma (2009, pp. 13-23), claims tasks in the 'outside world' "require cross-discipline knowledge related to complex ill-structured problems". By defining educational assessment with reference to the 'outside world', he argues for recognising education to be concerning individual wisdom and development; hence learning stipulates a better understanding of other culture occurring outside the formal classroom background.

According to Masters (2013), traditional learning tasks and assessment are indifferent to developmental consequences to learning pathways; as such it is questionable to whether they will produce evidence of complexity of learning. That is, most traditional curriculum materials focus primarily on judging success in specific content only. Seemingly it is essential for all stakeholders, to reflect in what way the practice of assessment can be enhanced by this knowledge and in what way the assessment data originated ought be understood. The significances of such an attitude to assessment is a consulting of the practice of curriculum pedagogy, and assessment towards a holistic emphasis in what way growth occurs, and upon the particular evidence required to demonstrate its occurrence.

Masters (2013) model of pedagogy and content follows a developmental perception. To embody a growth perception, both pedagogy and content require meticulous thought and thorough investigation in order to confirm beyond superficial learning is actualy stimulated by the curriculum pedagogy. He insists these should be organised with respect to developmental outcomes and reflected personal learning. In addition, the type of assessment may also profoundly influence the nature of pedagogy and content. For example, the use of open-ended problem-solving tasks encourages greater conceptual insight and deeper understanding, whereas closed questioning promotes superficial, reproductive learning.

A major dichotomy exists in assessment between quantitative and qualitative, that is, behaviourist and constructivist approaches. In a report by the Department of Education and Training WA (1967) each tradition is described in terms of its underlying psychology, methods and values. For example, a behaviourist pedagogical perspective in which the convergence and assimilation of content is valued, is likely to lead the use of quantitative approaches to assessment typified by placing the value on the use of multiple choice, closed

answer, and true-false questions. On the other hand, a constructivist pedagogical perspective is probable to the use of qualitative approaches to assessment typified by the discovery of knowledge and development of understanding from new experiences in open-ended and complex contexts. In qualitative assessment tasks, authentication is demanded, characterised by the demands of higher-order thinking skills and set in the contexts which are as true to life and realistic as possible to supporting pedagogy and content (Mourshed, 2010). Accordingly, a significant inference is the necessity for proficient in the knowledge of pedagogy that enables the re-contextualisation of ICT practice (Abbitt, 2011).

Alignment between curriculum content and pedagogical practices

Lane (2004, p. 6) stated that "a regression in the practise of performance assessments had led to a lack of orientation between assessment, curriculum content and pedagogical practices with respect to stimulating complex cognitive thinking". She raised concerns about the content validity of such assessment happening to the intended learning outcomes. For example, if fundamental learning outcomes are compromised because they tended to be challenging in measuring them, then attention to those areas of complexing thinking will be minimised. Lane contends this in turn leads to a misalignment between assessment and instructional practices to the detriment of eliciting higher order thinking. Kozma (2009) suggests a rationale for change in terms of curriculum misalignment. Differences exits between standardised pen-and-paper assessment and authentic tasks in the real world. For example, typically performance tasks present students authentic problems to solve, leaving them to choose the optimal method and most appropriate digital tools. These tasks attempt to imitate the real world, problem-solving situations in which there may be no single solution and no established solution algorithm. In contrast these higher order cognitive proficiencies such as investigation, production and appraisal go unexamined in standardised pen-and-paper assessments.

Furthermore, curriculum developers internationally have grappled with how any such assessment can be congruent with the intent embedded in several syllabuses, the challenge the longstanding threat to 'theory' and 'practical' forms of knowledge being dealt with separately (Newhouse, 2013; Penney & Hay, 2008). For example, the Physical Education Studies course in Western Australia school curriculum requires the combination of abstract and applied or performance-based learning in schooling and assessment, including the external examination

component of the course. It has a significant performance component based pedagogy that is not parallel with assessment using paper and pen.

Similarly McGaw (2006, p. 2) noted the impact of summative assessment on the curriculum to be of critical concern because of the excessive attention given to those aspects of the curriculum that are assessed. McGaw commented that "risk-taking is likely to be suppressed and there is less likelihood of the productive use being made of formative assessment". For example, when scholastic assessment of skills and knowledge is made, *pen and paper* testing limits the scope and form of assessment to non-performance outcomes. Constructs, which cannot be tested by writing about them, fail to make the test, and their omission inevitably compromises the content validity of an assessment (McGaw, 2006).

The problem of alignment between assessment, content and pedagogy has been well discussed over the decades; however, according to Lane (2004) this has become more pointed as digital technologies have rapidly changed society and gradually influenced curriculum and pedagogy. It is evident from literature reviewed for this study that many researchers concurred that, what is taught should be assessed and what is taught should reflect the needs of the individuals. From this perspective, the role of "assessment is directly linked to student learning" (Masters, 2013, p. 53). As such, the consideration of evidence of, and about, growth of knowledge, understanding and skills is important. Therefore if curriculum intentions change, so that teaching can be differentiated and further learning progress can be monitored over time, this should be reflected in assessment practices. The principle of learning processes and objectives could only change if assessment correspondingly changes. Assessment is a fundamental constituent of learning and teaching equally it acknowledges the quality of both teaching and learning to be arbitrated and improved (Cachia et al., 2010). For example, assessment is an integral component of a curriculum and the two need to be complementary and transparrent.

Assessment is important to support student-learning

Assessment is not only important for the teacher and the curriculum but also for the student in its support of learning experiences, skills and achievements. This is often referred to as assessment for learning (Masters, 2013). The range and methods of evaulation practices in learning and teaching amoungst eduators have customarily dedicated on scrutinising knowledge and facts throughout formal testing and do not easily lend themselves to grasping 'soft skills' (Redecker et al., 2010). Currently, a growing understanding that pedagogical

practices and assessment strategies must be reviewed to meet the proficiencies required in accordance within modern living (Cachia et al., 2010).

The Early Years Learning Framework for Australia (EYLF, 2011), suggests that assessment for learning is concerning the progression of collecting and examining evidence about what students understand and can do. According to Siraj-Blatchford and Sylva (2004, p. 17) understanding the journey embarked upon by learners is significant since it supports educators in partnership amongst all stakeholders to appreciate and collaboratively to:

- Plan effectively for students' present and future learning;

- Communicate about students' learning and progress; and

- Identify students' strengths and limitations and exercise intervention strategies in order to support particular learning outcomes.

According to Assessment of where learners are currently in their learning is important, because through stimulating knowledge concerning the existing situation ie., student-learning, experience and success, is likely to support student-learning progress. Masters (2013) avers assisting the teacher in identifying, achieving and gaining additional analytical empathy of a student's learning progress. Additionally, digital technologies potentially could provide wide-ranging assessment tasks through valuable response tailored to discretely developmental levels. Therefore, it is important appraisal practices contain a distinct collection of approaches to capture and validate different students' journeys towards their goal/s. Sometimes known a 'stealth assessment', assessments embedded within learning have been found to reduce test anxiety and are less disruptive to the flow of learning (Kleeman et al., 2011; Shute et al., 2010). These authors describe how embedded assessments can be used formatively as knowledge checks in a variety of multimedia forms, such as wikis, social networking sites, blogs, or web pages on computers or mobile technologies. Masters adds it to be equally as important assessment processes should not only emphasis wholly by the conclusion of students' learning, particularly in terms of performance assessment, because there is a continuum along the developmental pathway in learning progression. Assessment is important to identify the next steps in learning.

Masters (2013) explains that it is important for students and teachers alike because, assessment is about addressing the full range of learning outcomes, including the 'growth' of knowledge essential in identifying the learning progressions. Furthermore, he states it to be

important to investigate and deliver understandings of where learners are in their learning. In providing information about where individuals stand on their journey of learning would enhance the predication as to what experiences and accomplishments are expected towards additional learning, and what learning development is attainable over time.

The end result in an assessment is to draw a assumption from accumulated evidence in order to support student-learning progression. To represent a development perception in assessment necessitates systematic rational investigation, in order to confirm that more than superficial learning is being encouraged in pedagogical practices (Masters, 2013; Stobart & Eggen, 2012). Generally educators concurred with Masters (2013) definition in terms of educational assessment with reference to growth, and would agreed that there are certain challenges to present practices, for example, curriculum necessities need to align with respect to developmental outcomes that clarify predictable learning pathways, and schooling are likely to yield evidence of the depth of learning. For Masters (2013, p. 63) "assessment conclusions are usually focused on how well students are mastering the taught content, that is, how well students have performed overall in the course progress within a domain; it focuses on only one aspect, task performances, of a complete learning assessment system". Stobart (2010, p. 63) contends "that measurement theory assumes tasks have been developed to address some well-understood learning domain". For example, competence scales that result are 'post hoc' in the sense they are composed from appraisal statistics and are typically not connected to or verified against previous conceptualisations of the learning domain. Generally, most grading schemes commonly combined marks or grades to attain an overall result. These results could not feasibly translate into a position where students stand in their learning progression in an area, because they are confounded by such task difficulties as measuring a selected sub-set of learning only, this view concurred with many current literature within the domain of educational assessment researchers.

Assessment is important to motivate learners and provide feedback

Previous sections have revealed there to be a strong link between what is assessed and what is the focus for teaching and learning; this is well supported in many current educational literature reviews (Griffin et al., 2012; Krajcik, 2011; Masters, 2013). Students may be reluctant to invest time in an activity which does not directly impact upon their final grade. Similarly parents and teachers outcomes in assessment are like a payment benefit element;

thus it is potentially an important factor that motivates. Therefore, assessment is important to motivate learners and provide feedback to them, parents and other educators.

Assessments likely to assist the motivation of learners are those driven by intrinsic values. As Masters (2013, p. 23) puts it, "People are more likely to remember and learn if intrinsically motivated and emotionally engaged" Sensitive engagement inspires the brain to acquire, and individuals are further likely to recall when their feelings are stimulated, and when they are highly motivated and very observant (OECD, 2007). They will make use of their ability to self-direct their learning (Wiggins, 1990). Garrett et al. (2009) indicate computer-based assessment tends to have positive effects on students' learning and performance, partly due to the motivation of using computers. Integrated assessment formats can be supported by digital technologies that comprehensively capture 21st century skills and the capability to closer response to the authentic performance; it has a further effective impression on successive performance and student incentive.

Assessment is important to provide information as a basis for selection and certification

Global educational organisations are constantly measured by the results of student performance on standardised public examinations (Nunan, 2010). By the end of a unit of learning, typically at the end of a year of schooling or a course, there is almost always some form of assessment. Most often learners, teachers or institutions use this assessment as a basis of selection and certification. The score could contribute to a rank that forms the basis for proceeding to future study. It might also have a predictive validity in future success selection factor in employment. Teachers are also important stakeholders but for them the purpose of assessment is different; it provides feedback on their teaching, leading to evaluation of method and possible improvement.

Purposes of Assessment

This section commences by discussing the three broad purposes of assessment: summative, formative and diagnostic. These are then considered for their of relevance and importance in relation to high and low stakes of assessment in measurable goals. Finally a discussion on targeting wherein learners are concerned with motivation, certification and feedback.

Summative/formative/diagnostic

Evidence concerning the accomplishment of student learning could be composed either mid-course or used to guide further teaching; this is formative assessment. Where evidence is composed at the conclusion of a sequence and used to judge overall student success summative assessment is invoked (Masters, 2013). These assessments lie along a continuum of distinguishing between formative and summative domains. These dichotomies of purpose when considering assessment formed the foundation for conceptualising and defining the field of assessment: formative versus summative and continuous versus terminal assessment of learning (Scriven, 1967). Masters asserts that in reality, "formative and summative assessments often differ only in their timing; they are undertaken within the same general paradigm of judging how well students have learnt what they have been taught" (p. 57).

The notions of formative and summative assessment were initiated to support assessments not merely upon conclusion of a course of instruction, but similarly to be made throughout the curriculum (Bloom, 1968). The distinction between summative and formative assessment was formalised by Scriven (1967) as summative assessment aims to describe what has been learned after teaching is completed, and formative assessment is continuous, diagnostic and remedial. Summative assessment tends to be for certification, selection and pathways, hence reliability of measurement is very important, because the measurement determines the learner's suitability to future opportunities of progress. It ensures students are ready for the next level of education or employment, reflecting the needs of society (Lane, 2004; Masters, 2013; Ridgway et al., 2006). Summative assessment is based on performance criterion testing or performance in relation to others learners, that is, Norm-Referenced Testing (NRT). Formative assessment only makes sense when applied to learning objectives or criteria labelled. Criterion Referenced Testing (CRT). According to Masters (2013, p. 32) "diagnostic assessments are commonly undertaken to identify gaps in student learning, namely taught content that has not been learnt".

The purpose of summative assessment is to identify the relative competence achieved by students in all aspects of the course completed, it is terminal, finite and descriptive (Biggs, 1999). As a case in point, is the WACE accreditation of Year 12 students in the WA school system. Formative assessment aims to inform the learner of the current state of learning during the teaching process through term tests or exams. Formative evaluation is continuous, diagnostic and remedial (Biggs, 1999).

High stakes assessment

Generally high-stakes assessment is dominated by demands for accountability, accreditation and scientific rigour. An assessment is considered high-stakes when its results obligate authentic significances for key stakeholders (Heubert, 2000; Kirkland, 1971; Phelps, 2005). As a result, high-stakes assessments are usually summative in nature, although they may also play a formative role. Students are given summative assessments usually at the conclusion of an arranged theme throughout or at the end of the semester or year to evaluate what has been leaned and in what way it was learned. Results are typically a product of summative assessment; they include whether the student has an adequate level of knowledge in answering the question, is the student proficient to progress successfully subsequently (Hanna & Dettmer, 2004). Once these data are gathered, measurable goals can be established. Consequently assessment appeals to one's judgement to define the complete worth of an outcome based on assessment data; this is an accountability process. Thus high-stakes assessment establishes accountability and accreditation by providing measurable goals.

The use of standardised testing may be valid in various application to learning, however currently there is continuning discussions of their mis-alignment with currriculum and instruction. Many educational researchers have questioned about whether improvements in test score performance essentially is an indicator for improvement in learning with standardised tests (Cannell, 1987; Linn et al., 1989; Shepard, 1990). Some literature disscussed their neglect of higher order thinking skills, and the limited relevance and meaningfulness of their multiple choice formats (Baker et al., 1989). The modern trend of testing assesses higher order abilities and skills, the learners could demonstrate their proficiency on a progression scale (Masters, 2013). This type of testing tool focuses on the growth-performance of the learner

However, when test results are linked to rewards or sanctions, studies have found that "high stakes" testing leads to narrowing of curriculum and the pedagogy. Madaus (1998) noted that teachers taught to the test when they believed important decisions, such as student promotion, would be based on test scores. Smith et al. (1989) found "pressure to improve students' test scores caused some teachers to disregard material that the external test does not embrace reading real books, writing in authentic context, solving higher-order problems, and creative and divergent thinking projects" (p. 268). McGaw (2006) echoed similar sentiments particularly in courses with performance-based assessments.

Low-stakes assessment

Low-stakes assessment, by contrast to high-stakes, has a reputation for being softer and less judgemental (Hall et al., 2004). It is concerned with the immediate learning needs of the student and often makes use of interpersonal techniques. As a result, low-stakes assessment tends to largely be formative in nature. Low-stakes assessment tends to provide feedback while learning is occurring. It monitors student development but it also considers pedagogical practices. Furthermore, low-stakes assessment allows students to develop a constructive and active approach to their own development. Low-stakes assessment often mirrors high-stakes assessment in order for students to practice on achieving a specific task that 'matters'.

One of the primary purposes of low-stakes assessment is to enhance student responses in areas that may need improvement ie. implementation of a task and determining the success or otherwise. This is one way of reviewing the content or re-teaching it thus formative assessment allows a teacher to 'rethink' and 're-deliver' to confirm students' content understanding. These assessments typically are not graded and act as a gauge to students' learning progress and to determine teaching effectiveness in implementing appropriate methods and activities (Hanna & Dettmer, 2004).

Assessment to establish where learners are in their learning and to provide feedback

An important purpose of assessment is to establish the stage of learners at the time of assessment, that is, to provide them with feedback (Masters, 2013). According to Mourshed (2010) it is well understood that successful growth of knowledge is more likely when individual learners are given learning opportunities appropriate to their current levels of achievement and learning needs. In order to enable feedback to be relevant, formative assessment would be appropriate in the matter of 'timeliness' (Gibbs & Simpson, 2004). Higgins et al. (2002) state, "if feedback is not 'timely' students might not make the effort to go back to the assignment'' (p 55). "Timely feedback is essential to assist student learning progressions and teachers with opportunities to renegotiate the process of curriculum towards a holistic emphasis on how growth occurs and on what evidence should be gathered to show that it is occurring" (Masters, 2013, p. 4).

All students and teachers require timely and meaningful feedback; students need to understand their accomplishment on benchmarks. Teachers need it in order to understand who

is learning and how to orchestrate the learning process. This matter is highlighted in the OECD Innovative Learning Environments Project (OECD, 2010). Assessment provides essential feedback to the improvement of teaching practices by constantly reflecting and reviewing pedagogical practices and the impact of interventions, programs and improvement strategies. This allows for judgement to be made about a student's position in a pre-defined sequence of progression enabling the teacher to provide developmental- specific feedback to the student (Redecker & Johannessen, 2013).

Assessment to establish evidence of progress in the growth of knowledge

Assessment is typically conducted at a number of points along a learning journey and as a result gives the opportunity to provide evidence of growth of knowledge. Almost "all successful teaching relies on adapting approaches in the light of evidence about the success of previous episodes" William (2007, p. 248). This is likely to enhance motivation and improve teaching, because it encompasses prior evidence of success and may be used effectively in adapting to the growth of knowledge. Learning is assessed and hence starting points for future action are identified (Masters, 2013). Any form of assessment should be conducted in an environment conducive to allowing students' learning to flourish (Weeden et al., 2002, p. 16). Changes in results of assessment for a learner would indicate changes in growth of knowledge, a cycle in which evidence of incidental, ephemeral and continuous forms of assessment are used. This confirms the inter-connection between assessment, student learning and and the consideration of evidence about growth and development. As (Masters, 2013, p. 4) puts it "… personalised learning for assessment to establish where individuals are in their learning, … providing differentiated learning opportunities and encouraging self-monitoring"

Assessment to establish a basis for accreditation/ certification/ graduation

A key purpose of summative assessment is to identify students' skill and knowledge accurately thereby defining the selection criterion for the next level of education or access to careers, and quality assure education and achievement at the graduation level (Masters, 2013). Collecting assessment dats about student learning at the end of a course and used summatively to measure overall student success, would likely limit the use of assessment to inform decisionmaking. For example, students' skill and knowledge (learning) is not being viewed as a continuous process, instead summative assessment is usually employed to measure accomplishment on distinct groups of learned content. This then limits what can be

assessed and requires the assessment to be perceived to be accurate and fair, and use creditable authentication processes.

Consquences of educational assessment perform some high-stakes social purposes. Performance management and educational outcomes have intertwined and increasingly linked important indicators of the performance of teachers and educational centres at a local, national and international level, with all that entails for student and staff recruitment, retention and funding (Goldstein, 2001).

Assessment to determine pathways to further students' learning or career choices

An important purpose of all assessment is to provide students with information in order to guide and provide choices for improvement and further learning, or opportunities towards career choice. Currently the perception of learning is an ongoing, potential lifelong process, and to view every student as being on a path of learning with potential for further progress (Masters, 2013; Stobart & Eggen, 2012).

Assessment evidence should inform students as to whether they have the background knowledge for future pathways (Hattie & Timperley, 2007). This information should assist in the next step in their developmental pathway. Different sources of evidence about student growth should converge. For example, in a particular case there are different attainment signals coming from background information. Such analysis should then lead to more effective understanding of choices for improvement and further learning.

Parameters of Assessment

Irrespective of the purpose, all assessment involves some form of measurement of student knowledge or skill as demonstrated through a task, or set of tasks. Measurement about complex practical performances or deep conceptual knowledge gives rise to concerns about validity, reliability, comparability and fairness (Clarke-Midura & Dede, 2010; Masters, 2013; Weeden et al., 2002).

The concepts of reliability and validity are paramount and interrelated (Messick, 1996). Reliability refers to stablility and consistency results, and validity refers to how sound a test measures whatever it purports to quantify. For example, a test designed to assess student learning a CAD program could be given to a class of students twice, with the second administration perhaps coming a week after the first. The obtained correlation coefficient

46

would indicate the stability of the scores. While reliability is necessary, it alone is not sufficient because in terms of validity it may not 'measure what it is intended to measure' (Brown, 1968). The following sections discuss these parameters of assessment.

Validity

The validity of an assessment describes its ability to measure what it sets out to measure (Stobart, 2010). That is, the adequacy and appropriateness of the interpretations made from the assessments (Lin & Dwyer, 2006). According to Messick (1994) validity is an integrated concept made up of six clear and independent aspects, which must not be viewed in isolation but as complimentary forms of validity evidence. These are content validity, construct validity, substantive validity, structural validity, generalisability, and external and consequential aspects of validity (Clarke-Midura & Dede, 2010; Masters, 2013; Weeden et al., 2002). A description of each of these interdependent aspects is discussed in the following paragraphs.

Content validity refers to the features of the domain of knowledge the assessment intends to reveal (Gielen et al., 2003). It is the easiest and most likely to be achieved as it concerns correct content in terms of domain knowledge. The assessment focus is on the intended knowledge needing to be assessed. The thinking processes experts employed to solve a problem in real life must also accord with the assessment task Gielen et al., 2003). For example, authentic competency-based assessments are expected to have higher construct validity for measuring competencies than so-called objective or traditional tests. Messick (1994) argues that construct under-representation is one of the major threats to construct validity, which is countered by increasing the authenticity of the assessment. Authenticity, he argues, deals with not leaving anything out of the assessment of a certain construct, that leads to minimal construct under-representation.

Examples of student performance assessments were also discussed by Newhouse (2011); these and would be seen as highly authentic, having high content and construct validity, because 'authenticity' is related to 'content' validity (Brown, 1999). Therefore learning areas such as Design and Technology, Arts, Languages and Phsical Education can be validly assessed in part through direct observations of student *performances*. Messick (1994) suggests that appropriateness, meaningfulness and usefulness of the specific inferences can be made on the bases of observations or tests results.

Substantive validity describes the consistency of the assessment; it is concerned with the suitability of the sampling and coverage of the content under review Mislevy et al. (2013, p. 13) have suggested that:

> *the salient features of whatever the student says, does, or creates in the task situation, as well as the rules for scoring, rating, or otherwise categorising the salient features of the assessment.*

Structural validity describes the consistency of the assessment and scoring process, that is the fundamental feature evaluates the dependability of the scoring structure to the structure of the construct domain at issue (Loevinger, 1957; Messick, 1989). For example, Messick contends, "ideally, the manner in which behavioural instances are combined to produce a score should rest on the knowledge of how the processes underlying those behaviours combine dynamically to produce effects" (p. 746). He further states the internal structure of the assessment, that is, interrelations among the scored aspects of task and subtask performance, should be consistent with what is known about the internal structure of the construct domain. As (Loevinger, 1957, p. 746) puts it "construct-based rational scoring models is called structural fidelity" For example, tests can differ in their surface characteristics in such ways that equivalent evidence about examinees' proficiencies can be obtained (Mislevy et al., 2013). Thus conditional inference, which means taking certain information into account specifically, rather than averaging the ways it might vary. Assuming on specified teacher response is an infertile approach for the improvement of complex learning in a complex world. According to Sadler (2009, p. 9) "intensive use of purposeful peer assessment as a pedagogic strategy, not just for assessment but also for the teaching of a substantive content of the course if this process were to be entirely successful, the need for substantial reliance on feedback from the teacher would be obviated altogether".

Consequential validity contains the test score clarification and test score procedure thereby creating conclusions of the assessment consequences, and are defined as the backgrounds of implicit relationships worthy/unworthy, appropriate/inappropriate result clarifications (Messick, 1989). The major sources of construct irrelevant variance are contexts, methods, and observation, regardless of the source. The primary consequence of irrelevant variance is that it distorts the picture of student ability being measured, such as the student variable issues of demography, culture, and language variations. According to Kozma (2009, p. 746) "high-

stakes assessment apply when, a need to improve the criterion-related validity, construct validity and consequential validity becomes apparent".

Generalisablity describes the variety toward which other assignments might equally epitomise the construct or aspects of the construct (Clarke-Midura & Dede, 2010). Through the situation, performance assessment inclines to address validity but it needs to reflect the consequence on other values, such as the adequacy of 'generalisablity' and 'transferability' in an assessment where 'task performance' is the driver of assessment. For example, can similar aspects of an assessment task in maths be applied to English and yield a similar outcome? For example, Shavelson et al. (1990) examined the generalisability of performance across different practical performance tasks in science. They empolyed challenges such as experimentations to control the permeability of paper towels, and tests to discover the responses of sowbugs to light and dark, and to wet and dry conditions. Coherent by the results in other contexts, they establish performance was extremely task dependent. The narrowness of generalisability from task to task is consistent with research in learning and cognition, which therefore emphasises the state and specific nature of thinking (Greeno, 1989).

Nonetheless, the inadequate degree of generalisability within tasks needs to be taken into account in the design of an assessment program. This occurs generally cumulative number of performance assessments for all students, or by a matrix where a dissimilar performance assessment is administrated to discrete samples of students. The view exists that transferability within a domain, can be addressed by using a task design (Baker & Herman, 1983). Currently kinds of problems to be resolved, experimentations to be conducted, or poems to be studied, are stated in advance and assessment tasks are created to represent methodically critical dimensions. The rational assessment of this approach in instructional development is clear (Baker & Herman, 1983), giving a clearer understanding of the alignment of task specification across topics within a domain in terms of generalisablity.

In summary, Palm (2008) proposes that, "Validity refers to the appropriateness, meaningfulness and usefulness of the specific inferences that can be made on the basis of observations or test results". How we observe and measure performance and the method of task assessment depends largely on the nature and purpose of the assessment task. Messick (1996) suggests the values of validity pertain to all assessment, incorporating such performance assessments as student portfolios which are often the basis of inferences. This is not only concerning the quality of the included products, nonetheless also about the

knowledge, skills, or other attributes of the student. Such inferences about quality and constructs is essential to meet standards of validity. Messick (1989) contends that the importance performance assessments, though an imperative of industrial and military applications, remain touted as alleged instruments of standards-based education transformation since they promise positive consequences for teaching and learning,

The concept of validity was at the core of this study, forming the key concept under investigation. Therefore the purpose of this study was to find ways of improving the validity of assessment in the Engineering Studies and AIT courses. It could be argued that paper-based assessments of both of these courses have poor validity within the validity domain of assessment in all aspects except perhaps the predictive, namely success in one paper-based examination may be a good indication of potential success in another.

Reliability

The need for reliability and dependable relies on an assessment tool. It is generally accepted that concept of reliability with regard to an assessment is similar to the property of measuring instruments, that is, irrespective of who performs the measuring and when or where the measuring is carried out, there is stability and consistency (Shermis & Di Vesta, 2001).

Various ways of determining reliability are utilised, such as, test-retest, multiple assessors, multiple items or evidence: all these could be meet the requirements of statistical analysis (Scriven, 1967). Reliability with respect to generalisation to other tests, which might be similar tests with different questions, should deliver the same results. Decisions on assessment reliability relied upon the quantity of domain-appropriate evidence (Masters, 2013). As suggested by Masters (2013, p. 39) "the level of confidence placed in assessment conclusions increases with the amount and quality of evidence; in 'inter-rater reliability', interpretations are used to describe proficiency scales". Reliability coefficients in terms of internal consistency measures are based on the relationships between different items on the same test on a larger exam. They measure whether several items that propose the same general construct produce similar scores.

Comparability

Comparability concerns to the "consistency of levels of achievement within a subject across other comparable assessments" (Masters, 2013, p. 40). Consistency is achieved in the contexts of assessment task across schools. It is arguable that the comparability of school-based

assessments depends on the extent to which teachers share a common understanding of criteria and standards for assessment. It concerns the extent to which teachers throughout the system would allocate the same levels of achievement to samples of student work (Hill et al., 1993).

Collaborating with other teachers in the same learning area through moderation activities could also attain comparability of assessments (Sadler, 1993, p. 23). Moderation activities are likely to increase the consistency and comparability of the assessments, when describing proficiency scales using an external subject examination as a point of reference. This reference point helps rescaling school assessments or identifying and following up schools whose school-based assessments appear unexpectedly high or low in relation to external exam results (Hill et al., 1993).

Fairness

The properties of 'fairness' in assessment should allow all students 'equal opportunity' of *assessment quality* criteria, which includes validity, authenticity, transparency and equity. Some examples of fairness could relate to issues of existing practices and expectations, and degrees of access to and ICT capability of students and teachers. The fairness of the assessment is risked if unfairness exists either in the assignment or in the marking of. Bias in a assignment is like the idea of superfluous interference; such effects that systematically affect entire groups of students rather than individual students. In general, results of assessment should not depend on student characteristics not relevant to the assessment (Pettifor & Saklofske, 2012). In addition an assessment process should not be bias on the any way or form of discrimination (Masters, 2013).

The term *assessment task*, student response, and *task assessment,* assessor reactions, must be amenable to *assessment quality* consistency. The end result is the general fairness and suitability for purpose of the assessment task including validity, authenticity, transparency and equity (Campbell, 2008).

Types of assessment

This section discusses different types of assessment and how notions of deep and superficial question types may influence assessment outcomes (Masters, 2013). Masters model of pedagogy and content suggests the use of closed questioning promoted superficial, reproductive learning; whereas open-ended, problem-solving tasks encourage greater

conceptual insight and deeper understanding. Fitzpatrick and Morrison (1971) noted performance assessment to be synonymous with performance-and-product assessment. In this section, the discussion centres around three types of assessment based on response questions, production of a product and performance.

Response to questions that may be closed or open

An assessment task may simply be one word responses to written or oral questions that may require a closed or open response. Likewise for the constructed-responses (Livington, 2009). The types of assessment may also profoundly influence student types of response. The notions of deep and superficial question difference, can be understood if closed questioning is considered as promoting superficial and reproductive learning, whereas open-ended, problem-solving tasks encourage greater conceptual insight and deeper understanding (Watkins & Hattie, 1985). Darling-Hammond and Anderson (2010) discussed standardised or course prescribed assessment do not generally allow for differences in individuals' performance other than constructed responses, hence lacking stimulus of complex cognitive thinking.

Product and performance

Significant discussion occurs in the field of performance assessment regarding its nature and relation to the concept of product aligning with to-life contexts (Wiggins, 1990). In this regard, Messick (1994, p. 14) argues "a performance assessment typically has a process associated product and the final presentation as such either one or both process and product could judged. In a production task, such as painting a picture or playing a musical piece, only the end product is of interest". By contrast, a production and performance assessment, for example, performance of a scientific experiment, places value on both the result or end product and the process by which the product was developed.

At the same Messick (1994) points out that, in subjects, such as the performing arts, the product and the performance are a unity, as occurs in the assessment of proficiency with a musical instrument or of an acting skill. The use of problem-centred approaches to assessment of practical performances in fostering deeper understanding is well supported (Masters, 2013; McGaw, 2006). For example, painting a picture, the diversity of possible techniques makes assessing the process meaningless; the end product only that counts. In cases such as these, assessment makes no inference about the underlying skills and knowledge of the students. In other subject areas, such as scientific experiments, both the end product and the process are

important since correct procedures, like safety practices are also valuable and amenable to assessment.

What is performance assessment?

Performance assessment is based on the performance of a task, that is the application of knowledge. "When learning, people acquire content knowledge, skills and develop work habits; and apply of all three to authentic situations" (OECD., 2007, pp. 71-73). In the case of students, the performance must be viewed or captured to allow assessors to draw inferences about student knowledge and skills from a task or sets of tasks and work habits. Evidence could be captured by observing the performance or a product or recording of the performance (Dede, 2003; Masters, 2013; Newhouse, 2012).

Drawing inferences from performance evidence

Assessment is a about the timely collect evidence and of constructing interpretations from that evidence for various purposes. The crucial process involves describing procedures for making valid inferences from the evidence of a student's learning. An inference about learning is a conclusion about a student's cognitive processes; they cannot be observed directly the conclusion must be based instead on the student's performance (NCTM, 1995). Many potential sources of inference from performance evidence are available. An example in mathematics assessment includes evidence from observation, interviews, open-ended tasks, extended problem situations, and portfolios as well as more traditional instruments such as multiple-choice and short-answer tests (Jacobs et al., 2006).

A valid inference requires adequate and relevant evidence; as such interpretations depend on the interpreter's knowledge and judgement in using the evidence. The validity of inferences depends on teachers' or markers' expertise and the quality of the assessment evidence collected (NCTM, 1995). For example, in analysing scores, require relevant evidence and are founded on the best professional judgement. This evidence may be drawn from multiple sources, such as interviews, observations and collaborations the latter being show and tell sessions.

According to Baker and Jackson (2010, pp. 538-551) "The kind of evidence required is dependent on the consequences of the inference" For example, during an informal interview of a student a teacher could have sufficient evidence of the student's progress to permit the teacher to decide what learning path is best for the student follow on. On the other hand, a

large-scale, where results are used for certification or a culminating experience, involves much more multiple sources evidence and a more formal analysis of that evidence (Redecker, 2013).

Alignment of performance with context

An evolving perception within the business and education communities is showing a need to develop assessment methodology to address wider choice of proficiencies and qualities essential in the 21st century. Thus performance-and-product assessment is necessary to measure ability to solve complex problems (Masters, 2013). Masters refers to complex-performance assessments as "realist problems or authentic tasks, that reflect the intention to have students solve real world problems in true-to-life contexts" (p.1).

Realist events are both replicas of, or analogous to, the 'types' of events encountered in modern living in the 21st century. Authentic contexts for performance assessment are associated with of process-and-product-based evidence and less written responses. Therefore decisions on process-and-product based evidence for performance assessments is embraced in current literature (Masters, 2014; Mislevy et al., 2013; Redecker & Johannessen, 2013). For example, seemingly the practicality and usefulness of these assessments are used mainly for vocational education, such as Design and Technology, Physical Education, and the Arts. The nature and context of these performance-based assessment tasks had been deployed for consideration of job applications and in the training of engineers (Kozma & Schank, 1998; Quellmalz, 1999). The traditional perception of authentic contexts for competency-based assessment had developed more complex and progressively encompassing theoretical subjects within the school curricular.

Capturing student activity

Performance assessment requires the capturing in context of student activity in terms of product, process and authenticity. It is self-evident that what is taught should be assessed, and should reflect the needs of individuals and society (McGaw, 2006). Therefore, capturing student response in terms of product and process in performance-based activities is likely to enhance use of performance assessment. For example, assessing students' production of knowledge through task activities means to capture a sense of how they create and produce an artefact. This evidence could be captured by means of portfolios or audio-visual recording. For example, Lin and Dwyer (2006, p. 29) describe "capturing performances to represent

students' higher-order skills such as decisionmaking, reflection, reasoning and problem solving".

The assessment of performance in areas such as Art, Science, Physical Education and Technology and Enterprise concerns the capturing of authentic student activity wherein much emphasis is upon the achievement and evidence of practical skills (Fisette et al., 2009). High-stakes courses with major components involving performance of practical capabilities represent an extreme challenge to authenticity and establishing accountability in measuring goals (Newhouse, 2011). Eyal (2012) suggested performance assessment could also serve as platforms for numerous assignments, including the solving of authentic complex problems. Clearly these platforms invite the development of new criteria for evaluating learning. The belief that learners actively construct knowledge, based on the interplay between new and previous experience in social contexts, supports the use of complex performance assessments.

What types of performances?

This section considers the types of performances which may be employed to provide assessment evidence. The discussion centres on activating realistic problem or real world situations. These tasks are of a practical nature, that is, open-ended, production /performance, in which the measurement of students' creativity, ability and skill is necessary. This discussion relates to assessments of skill-performance, complex performance, open-ended problems and portfolios in terms of originality and creativity.

Skill-performance assessment

A skill-performance assessment concerns assessing discrete skills, for example, surgeons being assessed on a particular procedure or students kicking a ball. Thus, a single performance task is being judged according to a set of skills and these performances determine advancement. Another example of skill-performance assessment is 'Drills' in an activity where students perform a set of drills over specific period of time. Each student's completion of each set of drills and their performances are video recorded for feedback and further improvement. Skills/drills have the potential to reflect varying specialisations within an activity. Darling-Hammond and Anderson (2010) coined the phrase, 'trans-disciplinary learnings'. These tasks are designed to measure the integration of skills across disciplines (Klein et al., 1998). A growing body of educational research highlighted rich performance activities comprises constructs and responses and incorporate trans-disciplinary kinds of skills

and behaviours, such as doing science involves observation, designing, defining, collecting and analysing data. In doing maths is slightly more theoretical, nonetheless begins with observations of objects in space, the discipline focuses more on manipulating numbers, building facility with operations, translating situations into manipulating numbers, and building facility with operations. As (Stecher, 2010, p. 6) puts "These disciplinary manners of thought and action, educators in different fields may be thinking about different kind of activities when they refer to performance assessments".

Complex-performance assessment

Complex performance assessments could be closely allied to the terms of product and authenticity (Palm, 2008, pp. 1-11) Palm echoes this is significant in order for deeper learning to take place which concerns the importance of knowledge transfer. Facilities the purpose of understandings and skills for innovation, as being in an orchestra, participating in a sport or flying a kite, where application of skills is foremost in evidence (Masters, 2013).

Complex performance application of skills is evident in the e-Scape design project in which the application of appropriate process to product is facilitated in part by deep understandings of concepts, principles and key ideas of a learning area (Kimbell, 2007). For example, students being able to construct their own learning process and reasoning for their product production. This involves higher order thinking skills for the design project reflecting a degree of complexity and authenticity. Another inference of the term complex performance reveals that assessment increased the level of challenges to students' performance. This in turn stimulates more genuine and representative samples of students' work because the assessment task has more implicit meaning to them. Complex performance applications include "simulations of real world problems and portfolios of student work" according to Linn et al. (1991, p. 2).

Open-ended problems

Open-ended problem required varied methods of solution this involved the meaningful application of the student's own knowledge and/or feelings to the solution (Lin & Dwyer, 2006). For example, students are encouraged to choose the optimal method and most appropriate tools in solving situations wherein may be no single solutions and no established solution algorithm. These types of assessment tend to be more objective and rich in originality; they are generally central to engineering practice (Douglas et al., 2012). For

example, open-ended assessment is testing in which the examinee has to actually construct an original response to a problem challenge, such as landing a plane or painting a picture, where there is no fixed performance or product. Therefore, demands are high for authentic assessment tasks, which are characterised by higher-order thinking skills. These skills are set in contexts which are as true to life and realistic as possible for the open-ended problems (Wiggins, 1989). For example, practical performances activities within the curriculum can be validly assessed in part through direct observations of student performances on open-ended problems (Masters, 2013).

Portfolios

The use of portfolios in performance assessment has an advantage over an examination, because it permits the storing of evidence of events over a longer period and for more varied purposes (Masters, 2013). In addition, the evidence stored within a portfolio could be a product itself or a collection of evidence that represents a performance. The types of records of performance could include audio and video recordings of practical work. Portfolios are typically associated with creativity, where student's work is constantly built upon to demonstrate meaning and purpose.

Within practical domains of learning, 'products' are valid assessments, gathering evidence requires observations of the tasks/projects students complete, this being *products* of their work. Products could comprise works of art like paintings, drawings, photographs, sculptures and film, and works of technology such as metal, ceramics, wood food and textiles. A repository of processes employed by students is brought together in a *portfolio* of evidence, providing a valid basis for establishing current levels of achievement and for monitoring progress over time (Barrett, 2007; Lin & Dwyer, 2006). Complexity skills such as planning, investigating, producing, analysing and responding is validly evaluated through extended student projects (Masters, 2013). Furthermore, portfolios could be employed to motivate learner-centred activities that involve designing, decision making, and goal setting.

In the e-Scape project a digital portfolio was used in scaffolding ideas and skills in a process-and-product assessment. Thus showcasing skills, achievement, ideas and the creation of student work in real-time in a portfolio (Kimbell, 2007). The completion of an extended design assessment task for the purposes of summative assessment was captured in real-time in the nature and form of such as drawings, photographs, voice memos and notes. These artefacts in this portfolio were also supported by a variety of computer technologies.

Computer-Supported Assessment

According to BECTA (2006, p. 3) "since the 1960s educators have postulated uses for digital technologies in assessment processes, commonly referred to as computer-based assessment". Since the introduction of Computer-Supported Assessment (CSA) there has been a range of software applications written for the use of computers in assessment. This variety of applications covers a whole assessment process such as on-screen testing and marking, to assisting in one aspect of the task assessment process, optical mark and character readers (Bull & Sharp., 2000). The term CSA subsumes earlier, but still current, terms such as Computer Automated Assessment (CAA), e-Assessment (EA), On-line Assessment (OLA) and Computer-Based Assessment (CBT) (Govender, 2003; Thomson & De Bortoli, 2012). CSA is now enhanced with the integration of the Internet with e-Assessment process of assessment; it has major advantages, such as a platform-independence and anywhere anytime access (Baillie-de Byl, 2004; Woit & Mason, 2003).

From a report: *The Transition to Computer-Based Assessment* (Scheuermann & Bojornsson, 2009), Kozma (2009) discusses a basis for computer-based assessment in terms of curriculum content authencity and assessment fit for purpose of modern society what is assessed at school. In particular, he draws to the differences between standardised pen-and-paper and 'tasks in the outside world' based on 'complex ill-structured problems' and solved 'collaboratively' using 'technological tools'. Although Kozma does not consider assessment reform as only requiring the employment of digital technologies, he acknowledges current technology advances as offering exciting opportunities to design active and situative assessments, which stimulates higher cognitive thinking and provide rich observations for student learning. In addition Clarke-Midura and Dede (2010, p. 311) agree that the advancement of technologies offers great potential for the designing of challenging assessments.

One of the key beliefs is CSA has the potential and could tailor assessement to the achievement levels of individual learners, for example the provision of digital tools integral to modern practices i.e. 'on-screen testing', 'open-source platform Internet', 'anytime, anywhere access' (Kozma, 2009; Masters, 2013).

The advancement of educational technologies are relatively incremental; others are more disruptive. According to Masters (2013, p. 28) "Some of the emerging technologies we have either observed in educational practice or which will enter education in the next few years,

have promising potential for assessment. At present, society stands at the crossroads of two 'assessment paradigms' but lack a pedagogical vision of how to move from the old paradigm to the era of computer-based testing and, the era of embedded assessment" (p. 80).

Embracing computer technologies has great potential including affordability and is relatively cost effective. This is likely to enhance adaptability and increase the integration of CSA into modern educational practices such as supporting assessments, better feedback Johnson et al. (2012). The authors (Kozma, 2009) and Masters (2013) were adamant in endorsing CSA for assessment which is fundamental to educational practice. Along with trials and prospects surrounding the potential role of CSA in assessment practices, their beliefs is that it is important that assessment strategies encompass analysing factual knowledge and capture the less fundamental themes. Likewise Ridgway et al. (2006) echoed assessment strategies need to be harmonised better with 21st century learning approaches by re-focusing on the importance of providing timely and meaningful feedback to both learners and teachers.

This section will discuss the nature of computer-supported assessment and will examine the ways computers may support assessment. Then there will be a discussion of the assessment of practical performances, followed by ICT supporting different methods of assessment, and digital forms of assessment. It is important to understand the different methods and forms of assessment used, and the current advances in technologies offering exciting opportunities to design assessments.

The range of ways ICT may support assessment

With the advancement and affordability of ICT it is economically feasible and practicable to embrace the potential of digital tools to support various assessment processes in establishing measureable goals. ICT is needed to address the new types of skills and knowledge and to support current educational goals in replacing pen and paper assessments with more authentic forms of assessment.

This section discusses how computers may support every assessment process, for example, the delivery of responses, and the capturing of responses to questions, performances and productions. Computer support may also include on-line testing, providing ill-structured complex tasks, marking and specialisation of markers for specific curriculum content.

CSA may support every assessment process

As a logical extension to CSA, many educators have suggested that the authenticity problem in high-stakes summative assessment and ICT potentially may support this in establishing measurable goals or to support the marking or analysis processes (Dede, 2003; Lin & Dwyer, 2006; Masters, 2013; McGaw, 2006). In what could be termed 'end-to-end' electronic assessment, it is possible to support all assessment processes with ICT, from providing assessment tasks to marking, reporting and feedback (JISC, 2006). It can support current educational goals in replacing pen and paper tests with more authentic forms of assessment. Teachers employing ICT have the potential to provide varied assessment tasks with useful feedback customised to individual development levels, in ways consistent with an understanding of learning as an ongoing, lifelong process (Masters, 2013). Furthermore the arrival of online learning in the future "would likely reduce constraints, such as allowing personalised learning anywhere at any time. Such learning would require the support of ICT in the provision of a more appropriate assessment for learning environment" (Masters, 2013, p. 3). Masters went on to suggest digital technologies to have the potential to address this belief. In addition, students perceive the implementation of ICT in assessment may provide meaningful judgement of their work and therefore credibility in the validation of the outcomes sought in the coursework. The committee for the American National Academy of Sciences cites the use of computer-based adaptive testing, simulations, computer-based games, electronic portfolios and electronic questionnaires as having potential in fulfilling the purpose of high-stakes summative assessments (Pellegrino et al., 2001). This would be a motivational advantage, and according to Pellegrino, students prefer e-assessment to paper-based assessment because they feel more in control; interfaces are judged to be friendly; and because some assessments use games and simulations, which resemble both the learning environment and recreational activities.

In terms of marking and feedback, the use of digital databases or data banks will provide examiners to improve quality feedback (Hattie, 2003). According to (Pellegrino et al., 2001, p. 10) "Data matching and mining from databases or data banks unique types of data i.e. time, sequence and context of the assessments would seemingly improve the quality of examiners' reports, and opportunities to review and reflect on quality of questions, and the provision of information to student and teachers about topics that have not been learned well"

CSA supports the delivery of assessment in digital forms

The rapidly expanding repertoire of ICT infrastructure such as broadband, and the Internet have been accepted by many as a vehicle for the delivery of digital forms of assessment (Maloney, 2007; Richardson et al., 2002). Currently digital foms of assessment are setup as part of the UK government policy and awarding bodies are setup to accept assessment on-screen, including assessing e-portfolios. Maloney cites the basic and key skills test as being delivered 'on-screen', and 'on-demand' testing in situations where students were engaged in part-time study such as a differential curriculum enabling them to take tests at their own pace and time in various subjects. CSA delivery of 'on-demand' testing can accommodate part-time students and sessional courses. Assessment occurs only when students judge themselves to be ready (Redecker & Johannessen, 2013). Furthermore, CSA supports automated feedback so the actual assessment is quicker and timely. Judging learner readiness in a timely fashion when performance evidence is crucial at the point of need would appropriately adapt the level of difficulty of the tasks to the individual learners' progress accordingly (Ljungdahl & Prescott, 2009).

Evidently significant improvements in the development of CSA with regards to digital forms of assessment, including for national assessments of ICT literacy has been on-going over recent decades (Ainley et al., 2012). Likewise international assessments of digital reading (Schulz et al., 2010). According to Masters (2013, p. 14) "many early efforts to deploy technology for assessment were limited to the delivery of traditional test items on screen, or the development of collections of online assessment tasks as resources for teachers. These are relatively pedestrian uses of technology and are likely to be superseded in the future by much more powerful forms of assessment".

CSA supports capturing responses to questions, performances and productions

The wider use of digital pedagogical environments initiates ability to capture student response data authentically so that it can be used in drawing inferences about their knowledge and skills in an assessment. Not only can responses to questions be captured in a variety of forms such as text and audio, but also performances can be captured using audio-visual technologies, and productions can be represented in digital forms. One example given is the capturing of valid performance that may be judged in a reliable fashion by noting the progression of students' conceptual understanding over time (Thomson & De Bortoli, 2012). As Stobart (2010, p. 62) noted, "these data are not always being used to draw systemic

inferences about student learning". However, Wilson (2009, pp. 35-37) "describes the possibility of using 'educational data mining', that is the unique types/properties of data such as time, sequence and context, to extract assessment information".

Additionally the e-Scape project documents an extensive (6-hour) collaborative design workshop instead of the usaul school examinations for 16-year old students in Design and Technology (D&T) were conducted in 11 schools across England. (Binkley et al., 2012; Ripley, 2009). Students worked cooperatively in capturing assessment evidence of 'responses' and 'process' of their their planning, collaboration and designing via a handheld device. Kimbell (2012, p. 133) used "design talk, voice recognition software, and PDAs in supporting students' designing activities in the classroom". Creative and early exploratory phases of work were captured. Evidence of a performance and production such as working with CAD in D&T could be captured in a digital portfolio. These process and production activities were captured using external digital devices. Students' work was tracked and logged in real time in a website. These digital technologies were used in the capturing open-responses, and practical and reflective aspects of the e-Scape project. Using a portfolio management system to drive the activity forward with pace and purpose was an significant feature of CSA (Kimbell, 2012).

Most assessments provide 'snapshots' of achievement at particular points in time. Inferences from skills, performance and productions of realistic problem solutions are best captured via digital technologies (Dede, 2003; Masters, 2013; Pellegrino et al., 2001). Another example of CSA is supporting reflection and critical skills. CSA allows real-time collaboration in reviewing and improving digital work. Students can be asked to provide examples of their ability to improve work on the basis of others', their own suggestions, and of their ability to critique the work of others (Richardson et al., 2002). This may be done via pen and paper, for example, by writing on every third line, and changing pen colour at every revision cycle; it is made very easy by the use of ICT, with facilities such as 'track changes' in MS-Word (Patrick et al., 2010, p. 23).

The ability to deliver and capture student assessment performance in digital forms has many potential advantages. These range from doing traditional things in new ways, to extending what could be achieved traditionally, and onwards to supporting learning in new ways. Lin and Dwyer (2006) suggest "digital technologies need to be employed to capture 'more complex performances' thus assessing a learner's higher-order skills" (p. 29). In addition,

Spector (2006, p. 11) suggests "complex and ill-structured tasks can be used as assessment tasks reflecting real world situations"

CSA supports on-line testing

According to (Messick, 1994, p. 14) "The Internet has been visualised by many as primarily a vehicle for on-line delivery of information, but is increasingly considered as a vehicle for assessment". Several ways are extant for on-line testing to be used to capture an assessment process, these sources of such evidence are signficant for the presentation of the assessment activity. Furthermore key features of on-line testing are that students can do the tests anywhere and anytime and only need one copy of the test. This is a logistic advantage afforded by ICT supported testing; this was highlighted by Kimbell et al. (2007) in the e-Scape project which pointed positively to the feasibility of extending the combination of an online repository for testing, accessible constantly. Furthermore, Dede (2003) implies that on-line delivery of exam questions, utilising ICT multimedia, simulations and 'drag and drop' mechanisms, thus allowing students the opportunity of creating instructional videos on various topics; team assignments and collaborative unlimited world-wide research tasks. By integrating ICT into on-line testing and using multimodal forms and features into web-based materials, various software tools allow the capture of responses to 'closed' and 'open-ended' questions. On-line systems have been devised wherein students deploy computer systems to complete tasks or respond to questions. According to (O'Sullivan & Gibbs, 2006, pp. 31-36) "The simplest form is the answering of multi-choice and short-answer questions on the screen". However, the most complex are the uses of various software packages to create digital products. The former is likely to be completed online using browser, whereas the latter is likely to be completed locally and may be uploaded online or may be stored locally on a USB Flash drive (Siozos et al., 2009).

"An increasing proportion of learning occurs online and clearly assessment 'delivery' processes will also become increasingly technology-based" (Masters, 2013, p. 5). A large body of research concurred that the greater use of CSA the greater the possibility of enriching digital forms of assessment.

CSA supports assessment of complex and ill-structured tasks

Computers are currently being used incresingly to construct and support assessments. CSA have been enriched realistic tasks and to allow for the assessment of constructs either difficult

to assess or have emerged as part of the information age (Pellegrino, 2010). CSA may have the capability to address and support this complexity of open-ended tasks. These range from "doing traditional things in new ways, to extending what we could traditionally do, and onwards to supporting learning in new ways" (BECTA, 2010).

Previous results of computer-supported assessment, were mostly concentrated on efficiency and effectiveness of test administration; dealing with validity and reliablity of test scores. By providing a larger data bank of test methods that were receptive to automatic scoring, with a view to improve efficiency and validity simultaneously. Despite the variety of computer-enhanced test formats, eAssessment strategies have been grounded on explicit testing of knowledge.

Many ways are possible in which CSA may enrich assessment of higher order thinking skills through supporting complex open-ended ill-structured tasks. This was evident in the Queensland curriculum Technology learning area that encompasses design driven by essential processes of '*Ways of Working and Knowledge and Understanding'* (Queensland Studies Authority, 2007). Sources of evidence are collected from using sets of open-ended authentic tasks, like writing, oral, projects and models. Assessment process/techniques occur through observations, consultations, focused analysis, and peer and self-assessments. These processes are driven and supported by digital technologies. For example, sources of evidence from writing tasks such as design briefs and plans, design proposals, specifications and modifications are anecdotally recorded. The annotated work samples, together with other evidence was recorded audio visual or multimedia devices (Queensland Studies Authority, 2007).

Another example of such use of ICT is the practical exam component of Physical Education Studies, in which students from across the state attended examination centres located at various sporting facilities in Perth, Western Australia. The aim of the exam was to enable the ranking of all candidates' performances within a chosen sporting context; it concerned students' technical competence and ability to make decisions and apply skills to resolve tactical problems encountered during the assessment. Therefore, 'harder' exam 'questions' being presented to students was akin to higher order thinking. The performances were recorded using video cameras (Penney & Hay, 2008). These open-ended tasks are presented to students without a prescribed method and as a consequence they not only generated their own questions, plans and solutions, but they also had ownership of their products (Bransford

& Stein, 1993). The belief that learners actively construct knowledge, based on the interplay between new and previous experience in social contexts, supports the use of such ICT supported, complex performance assessments as essays, laboratory experiments and simulations (Darling-Hammond & Anderson, 2010, p. 7).

CSA supports better marking and feedback

Assessment evidence from marking and feedback needs to have concern for consistency or usefulness of evidence. Responses in order to be helpful to students learning must be timely and meaningful (Hattie & Timperley, 2007). Meaningful feedback is needed for both students and teachers to understand who is learning and how to coordinate the learning process. In terms to proformance tasks, digital devices or internet sources are resources are examples of how computers can be used to improve marking and feedback to students. For example, creative areas like Kimbell's e-Scape project sets out to assess process skills associated with design. This was significantly supported by online marking guides and the inclusion of rubrics. Collation of scores and analysis was achieved through a database and statistical software.

The use of student-centered data, where data-mining techniques are employed to predict and advise on learning already implemented in some environments to identify students who are at risk of dropping out or under performing. However, Learning Management Systems covers curriculum mapping, personalisation and adaption, predication, intervention and competency determination (Masters, 2013).

Used imaginatively, e-Assessment has the potential to provide varied assessments tasks with useful feedback customised to individual developmental needs, according to Masters (2013). He provides an example of the aptitude tests of coordination undertaken before air pilot training. Another example indicates the inclusion of digital files which may easily be compacted and transmitted, accessed and shared by markers, allowing the rating of performance to be achieved by more authentic and innovative methods (Lai et al., 2008). By making each student's performance available from an online repository, markers would have unconstrained access to assessment materials. CSA supports better quality marking in using complex simulation, sampling of student performance repeatedly over time, integration of assessment with instruction, and the measurement of new skills in more sophisticated ways (Bennett, 2010).

CSA may also improve marking through supporting specialisation of markers, that is markers/teachers who are subject specialists in their relevant curriculum areas. The quest for increased precision in marking of assessments is essential and markers need to ensure consistency in the overall relative merit of students' work (Masters, 2013; Pollitt, 2004). For example, these authors indicate CSA may also improve marking through supporting specialisation of markers by enhancing reliability. In the context of high-stakes summative assessments, reliability is synonymous with precision. According to Pollitt, using specialised markers in a limited of numbers of items would enhance consistency in the marking practices, and a defensible standard of reliability would be upheld and may be estimated.

CSA enhances economic benefits and logistics

Digital technologies are already widely available in Western Australian schools. Scarcity and expense involved in the acquisition of resources are no longer barriers to the use of CSA (Kozma, 2009). As new technologies are more widely used for the delivery of education and as an increasing proportion of learning occurs online, CSA is likely to support the logistics of exam processes by using ICT to smooth communications between schools and examination authorities in the distribution of scripts and items to markers (Masters, 2013). For example, by making each student's performance available from an online repository, markers would have unconstrained access to assessment materials thus being more time-efficient and cost-effective.

Furthermore, the continuous monitoring and ensuring high marker reliability would reduced clerical errors resulting in ICT being much more cost-effective than traditional methods of marking, especially because student work is scanned then distributed. This has advantages over conventional systems in terms of logistics, such as posting and tracking large volumes of paper which is economically unsound as implied by Koretz (1998).

Assessment of practical performances

This section discusses how ICT-enabled assessment of practical performance may be accomplished through performance-and-product based assessments (Darling-Hammond & Anderson, 2010). CSA may support this range and method of assessment procedures in formal education and training. In order to discuss practical performances it is important to understand the types of student work used for assessment, and the manner and method in collecting and interpreting performance-and-product based evidence.

A number of ways of providing a practical assessment component to technology courses are useful. In the USA, Educational Testing Services (ETS), the creator of the Scholastic Aptitude Test, developed an ICT Literacy Assessment tool to measure the ability to use technology research, organise, evaluate and communicate information (ETS, 2002, p. 17). The developers initially targeted post-secondary students with web delivered scenarios presenting test-takers with a series of simulated tasks, such as advanced searching, sorting, organising, presenting and communicating information. The report differentiates between tasks designed to assess proficiency, and tasks designed to assess and diagnose skills in ICT components, namely, the accessing, management, integration, evaluation and creation of information solutions. Practical tasks using digital-based resources are another promising avenue for developing ICT-enabled assessment formats, such as the national ICT skills assessment programme in Australia (MCEECDYA, 2011) which is designed to be an authentic performance assessment, mirroring students' typical 'real world' use of ICT. The focus here is on types of student work, collecting evidence of performance and drawing evidence from performance-and product-based activities.

Digital technologies may be used to support the collection of evidence of performance; this may be accomplished by providing environments and tools for (1) the representation of knowledge, (2) the recording of evidence to 'observe' performance, and (3) the process of interpretation and drawing inferences (Newhouse, 2010).

Types of student work

Basically all types of student work can be assessed using CSA. For example, from on-screen testing to assessing is but one aspect of the task-assessment process of recording performance or marking (Bull & Sharp., 2000). Therefore, types of student work could range from open-response tasks to 'more' complex performances that assess such a learner's high-order skills as decision-making, reflection, reasoning and problem solving or other laboratory simulation-type of tasks.

Types of student work to be assessed in this way could be an audio-visual recording of evidence about the production of digital artefacts such as an interactive webpage, graphics, databases and spread sheets. According to Pellegrino (2010), product-based skills are demonstrated through devising, creating, testing and implementing digital solutions in producing a product. For example, the assessment of students engaged in an activity requiring on-the-spot student reflective response about their performance. An example of an audio-

visual recording of evidence according to Newhouse (2012) could be a Physical Education exam design-task wherein students employed digital technologies when presenting a strategy for a tactical game challenge in a sport by typing and drawing using software. CSA supported and allowed students the opportunity to demonstrate knowledge and understanding through a structured critique of their own performance in digital forms.

Collecting evidence of performance

In order to assess practical performance, evidence needs to be collected. In terms of practical performance could be accommodated through digital technologies. For example, production exams in design and technology need only be represented digitally through records of performance like video, photograph, or scanned document. Technology-enhanced collection of performance evidence can also provide unique opportunities to assess students' understanding of important principles and ideas in an area of learning. This provides opportunities to track the processes students follow in attempting to solve problems and so provide a basis for assessing inquiry and problem-solving skills (Quellmalz et al., 2009). This evidence could also be accumulated via a video recording or an oral interview when seeking a rich range of attributes.

Evidence of performance from "open-ended problems, essays, hands-on science problems, and computer simulations of real-world problems may be collected in portfolios of student work" Linn et al. (1991, p. 3). This implies the need to consider and use CSA, as digital technologies have become more significant and prevalent in eliciting authentic performance evidence (Masters, 2013).

Interpretation of performance evidence

Digital technologies have the potential to support the interpretation of the evidence through marking, judgements or scoring of performances. Digital technologies can be deployed and open up many new forms of data capturing performance evidence. This was highlighted in a project 'Assessing Design Innovation' (Kimbell et al. 2004). In this example sound bites of students' immediate thoughts and reflections on the manner in which they were progressing were video recorded along with snippets of working prototypes. Computers offer many opportunities for supporting the interpretation of performance evidence, for example, digital technologies can capture complex skills and competencies otherwise difficult to assess. In the e-Scape project, students' work was recorded using digital cameras, PDAs and recording

devices strategically located around the classroom. The performance assessment evidence collected was interpreted through a series of comparative, paired portfolios using Thurstone's graded pairs.

Digital technologies can provide an authentic assessment tool enabling examiners to scan, and make judgements about learners' holistic performance (Redecker & Johannessen, 2013). Judgements on the achievement and performance of students are based on the data collected in digital environments; it must be a transparent and fair process of interpreting and evaluating these data, and mediated by digital applications and tools. However final control must ultimately lie in the hands of teachers and learners. The decisions and judgements will be guided by pedagogical principles reflecting the competence of the 21st century (Redecker & Johannessen, 2013).

All assessment involves a comparison of one thing with another (Pollitt, 2012). As Pollitt points out, it is not necessary for exams to be marked. The issue of reliability of performance assessment primarily concerns 'marking', with traditional approaches for summative assessment being as the sum of scores on micro-judgements (p. 5). He explains this approach is likely to generate scores with low reliability for the measurement of 'performance or ability' (p. 5), such attributies being not measurable in absolute terms and in isolation. Some way to judge students' performances is needed, but good reasons are needed to prefer holistic judgments. This does not require the precision of absolute judgement, that is scoring on an absolute scale. The end product of such analysis should lead to more effective understanding of student learning (Hanna & Dettmer, 2004).

Performance evidence from several parts of a student's submission on how they represent knowledge and develop competence in a content domain, could be judged with ICT support via Rasch modelling, which is analytical marking, or Comparative Pairs Marking based on *Thurstone Scaling* (Thurstone, 1927). The comparative pairs approach to marking requires assessors to select a 'winner' between a pair of performances and repeat this process for many pairs, the results being analysed using a Rasch model for dichotomous data (Pollitt, 2012). Pollitt (2004) describes the comparative pairs method as 'intrinsically more valid', but without ICT support it has not been feasible to apply due to time and cost constraints. McGaw (2006) contends such assessment methods, supported by digital technologies, should be applied in public examinations.

Future focus on evidence of convergence in technology deployment by students and teachers may well identify opportunities to enhance the interpretation of performance evidence in assessment, learning and teaching with technology in targeted ways Masters (2013). He implies that performance evidence is linked to evidence about growth and development directly. Thus, the fundamental purpose of assessment is recognising education to be concerned with personal learning, and assessment needs to take heed of evidence of progress in the growth of knowledge, understanding and skills. Therefore different sources of evidence from external settings about student growth should converge, there being value in adopting a holistic analysis in understanding student development and growth. Advances in technology has the potential to provide better information to guide and evaluate educational decisionmaking, better understanding of human learning, and support for the development of a broader range of life skills and attributes (Masters, 2013).

ICT supporting different methods of assessment

Different methods of assessment have been devised wherein students deploy computer systems to complete tasks or respond to questions. Computer-based exams have been utilised in many places for many years although rarely for high-stakes purposes (Messick, 1994). More recently, a renewed interest has arisen with a focus on '21st Century Skills' – considering a vast array of CSA, typically including assessing and marking of multiple choice and open-ended questions in computer-based exams. An example is the international research project, *The Assessment and Teaching of 21st Century Skills* project that was supported by Cisco, Intel and Microsoft. Literature about "Assessment for Learning" led Masters (2013) to suggest that digital technologies have the potential to enhance varied assessments.

The next section discusses the manner in which ICT may support computer-based exams, portfolios, and digital audio-visual recordings.

Computer-based exams

In order to understand different types of computer-based exams it is important to appreciate the number of forms of assessment that may be supported by the power of computers systems. Types of computer-based exams such as multiple choice questions and open-response questions will be discussed in the following sub-sections.

Over the past two decades, alternative forms of assessments supported by the power of computer systems have been conceived and tried. For example, the successful development

and implementation of audio-visual stimuli and response computer-based exams and digital production exams result in portfolios of evidence (Newhouse, 2013). Additionally, many educators have thought the assessment authenticity of practical performances may be enhanced through the use of digital technologies, predicting the technology may be used to record or represent a performance or to support the marking or analyses processes (Dede, 2003; Lane, 2004; Lin & Dwyer, 2006; McGaw, 2006).

Multiple choice questions

For many decades computers have been deployed to automate marking of multiple-choice questions and the statistical analysis of scores. As a logical extension, multiple-choice responses were completed on screen. Questions can be displayed in multimedia forms and a variety of choice can be given, that are in rich-text or graphical display, completed by fill-in-the- blank type responses; tick the boxes; and animated and sound stimulated responses, all of which can then be stored and marked automatically.

In an ICT adaptive environment, multiple-responses can more easily be tailored to the achievement levels of individual learners. For example, "when a bank of test items is stored electronically and a statistical estimate is available of the difficulty of each item in the bank, individual students can be administered items appropriate to their current levels of achievement" (Masters, 2013, p. 28). Current research concentrates on improving the reliability and validity of test scores. Some areas such as the improvement of selection procedures for large item banks are acknowledged (El-Alfy & Abdel-Aal, 2008 ; Masters, 2013).

Open-response questions

Fitzpatrick and Morrison (1971) noted performance assessment to be synonymous with open-responses. These effectively encompassed conceptual, practical and reflective aspects of the task. Different assessment methods are valid kinds of learning, for example, learning in areas such dance, drama, instrumental music, oral language, oral reading and physical education can be validly assessed in part through direct observations of student performances (Masters, 2013). Computer technology has increasingly been able to support all such forms of open-response questions.

In most pedagogical settings, teachers attempt to present students with authentic problems to solve, leaving students to choose the optimal method and most appropriate digital tools. The

digital forms might be students working with the application or productivity software on computer, video recordings and audio recordings or photographs of performances, or scanned work (Kozma, 2009). In a computer-based exam in which students are demonstrating a reflective or process aspect of a task by typed responses, oral recording and/or drawing with a stylus or mice or by means of moving animated responses are apt. These tasks attempt to imitate real world, problem-solving situations where a single solution is not possible and no established solution algorithm is available (Clauser et al., 1997). The problem is relatively open-ended, hence allowing greater complexity in its solution.

Portfolios of production of digital artefacts

Students may be assessed on the production of an artefact they have created using digital technologies. Digital artefacts concern creative work that could result in an artefact text, image, video or audio, such as digital art, music or CAD. Similarly ICT can deliver, monitor and capture the quality of work during production (BECTA, 2010; Fitzpatrick & Morrison, 1971; Masters, 2013). These digital forms allow for the scope and nature of enhancing students' work (Sadler, 2010). Generally, students are able compare the quality of their emerging work with higher quality, so drawing on a store of tactics to modify their work as necessary as they develop and produce an artefact.

The production of a digital artefact may be a response to a challenge given in a form of a design brief leading to the development of a prototype digital product, as was highlighted in the Digital Forms of Assessment report Edith Cowan University (CSaLT, 2011). The end product was captured in a digital form which has included the design and development processes. This then enables the recording of achievement and storing of evidence for a longer period of time and for more varied purposes than an examination. Accordingly ICT supports the recording of evidence in an organised collection of the practical performance such as text, graphics, images, photographs, audio and videos in digital files. This is similar to the *e-Scape Portfolio Assessment Project* (Kimbell, 2007) which centred on the creation, in real-time and digital form, of a student portfolio during the completion of an extended design assessment task in which students demonstrate their knowledge through the production of digital and non-digital artefacts. The digital artefacts included drawings digitised through photography.

Recording of a physical performance

Recording of a physical performance concerns using audio-visual recording such as video of a drama or sport, or audio of a song. Many educators suggest that to assess physical performance authentically, the aid of audio-visual technology should be employed (Dede, 2003; Lane, 2004). In learning areas such as Physical Education, student performances such as high jump or throwing a ball could be recorded, as could welding two bits of metal together or sawing a piece of wood in Design and Technology; ICT would support these assessment methods. Often these scenarios are difficult or impossible to create in normal classroom environments; thus students' physical performances are replicated and recorded electronically. Recording of physical performances can provide unique opportunities to collect evidence about students' understanding of important principles and ideas in an area of learning.

Digital forms of assessment

This section discusses how ICT affords the potential for the assessment in the use of digital portfolios, production-based exams, performance tasks exams and oral exams. A digital form of assessment occurs when evidence of performance is collected in digital form. Some digital forms are digital portfolios, computer-based exams and digital recordings of presentations or performances. Thus evidence so collected could reflect the authenticity the performance outcomes required and satisfy the best-fit principle in terms of forms of assessment (McGaw, 2006). School Curriculum and Standards Authority (SCSA, 2015c) offers the following advice with regard to the 'best-fit' principle. In deciding on a pupil's level of attainment, teachers should judge which level decription best fits that pupil's performance. Teachers will be able to balance one element against another using professional judgement rather than counting numbers of statements of attainment mastered and using a mechanical rule.

Digital Portfolios

A digital portfolio could be collated after the student has performed, or as the performance occurs. For example, portfolios could accommodate projects' phases submitted at various completion points or during their development as a formative assessment from a cumulative collection of students' work to evaluate performances (Koretz, 1998). The idea is that a student will have digital space which could be an 'e-portfolio'. Typically it is a space on the server where all of that student's coursework accrues. These methods can capture evidence,

not just of a student's work, but the manner in which they arrived at a particular response or performance. Traditionally, no evidence of the thought process students might have utilised is recorded (Kimbell et al., 2007).

The employment of a digital portfolio as a platform for assessment when complex problems are solved requiring information from a variety of sources. The form of assessment and design of the tasks leading to digital representations of performance are critical to the functional quality of the assessment (Pellegrino & Quellmalz, 2010). Digital portfolios provide students the opportunity in creating instructional videos on various topics, team assignments, collaborative research tasks and projects. All this evidence of students' performance is created and then submitted.

Production-based exam

Production-based exams require students to produce an artefact either digitally or represented digitally. A production may be addressing a practical problem with a full set of processes to develop a solution. For example, tasks which are essential in a practical nature, require evidence of student ability to complete a series of procedures and practices in order to finish a product such as a coffee table or remotely controlled robot, or the assembly of parts in the whole product (Eyal, 2012).

The use of a production-based exam may be the scaffolding for a series of design iteration sub-tasks of a problem scenario, outlined in a design brief for example, to design a solar shower or a means of collecting water on a remote desert island to a final solution. Throughout successive iterations of the design process, following some form of stimulus input, would likely lead students into revising their ideas that would then be reflected in students' sketches, models and audio-visual recordings (Newhouse, 2013).

Performance tasks exam

A performance-tasks exam comprises a series of tasks, not necessarily logically connected, to demonstrate particular knowledge and skills (Boyle, 2006). An example could be accomplishing a task using CAD on a computer to produce a skills task on drawing 'types of lines' that meet a particular convention for a form of drawing. Another example may be for a skill/competency requiring a particular type of 'weld' in a Design and Technology exam where evidence of discrete skills is appropriate.

Some examples of performance-tasks exams could be students performing a dance routine that emphasises mastering the skills needed for a particular movement or step. In physical education the performance-task exam may concern the ability to use correct techniques in a golf swing for tee off with the task strategy focusing on a 'tactical problem' (Griffin & Butler, 2005; Mitchell et al., 2006).

Oral presentation/interview

Digital recording of oral presentations and/or interviews provides authentic evidence whereby valid conclusions could be drawn. An example of such a task was a three-year study project into the use of computer-based oral exams in Italian language studies, conducted by Newhouse and Cooper (2013). As the course already had a tradition of assessing oral performance through a face-to-face 'interview' undertaken at a central location, the approaches used in this study were to simulate a conversation or record the student speaking. By recording an interview in Italian using a microphone and/or camera connected to a computer, students were able to collaborate and reflect on their learning and sharing experiences (Shrosbree, 2008)

Human-Computer Interaction

This section will review literature on human-computer interaction relating to the perceptions and attitudes of teachers and students towards using ICT in teaching, learning and assessment. The focus will be on attitudes, perceptions, culture and beliefs pertaining to the complex interactions between humans and technology involved with assessment processes and practices. This interaction could be affected by the characteristics of both human participants and machine systems (Kim et al., 2013). In the 21st century enterprise, teamwork, innovation and information sharing are growing in importance as more routine work processes are increasingly performed by computer technology (Kimbell et al., 2007).

The perceptions and attitudes of students and teachers are critical within the learning environment: therefore their perceptions and attitudes towards the use of ICT will be critical to successful integration of ICT into teaching and learning, including support for assessment (McGaw, 2006; Peeraer & Van Petegem, 2012). Where ICT is activated within assessment processes an understanding of the interaction between the technology and the humans is involved; the students' and teachers' attitudes and perceptions are critical to integration of ICT with the learning environment.

Clearly, the rapidly evolving nature of ICT ensures it to be prudent for users to update their knowledge and understanding of the potential need to use of ICT in their daily lives periodically (Elwood & MacLean, 2009). As (Roblyer, 2004, p. 15) puts it "The core purpose of accommodating ICT in education is to help students learn. Teachers must recognise and be prepared to work in this teaching and learning environment with all of its subtleties and complexities". For example, challenges in managing issues regarding the employment of ICT was identified as: comfort, interactivity, self-satisfaction, valueing new technology, experience and context (Shaw & Marlow, 1999). These dimensions underpin the teaching and learning, Roblyer having classified the 'subtleties and complexities' as having 'halo effect'. In this instance positive feelings about one aspect of ICT will impact on others. Therefore, Shaw and Marlow contend that in order to deliver an ICT enhanced curriculum to help students learn, teachers need to be mindful of a negative student attitude possibly compromising their learning experience about ICT supported learning. Therefore, it was of the utmost importance for this study to identify the beliefs students' and teachers' hold, and how this shaped attitudes and perceptions about utilising ICT for assessment.

This next section begins by discussing the attitudes and perceptions of students and teachers towards the use of ICT, and its employment learning environments. Finally their attitudes and perceptions towards assessment and ICT in assessment are discussed.

Attitudes and perceptions towards using ICT

Attitudes and perceptions towards using ICT concern the combination of self-efficacy, beliefs about the value of technology, and beliefs about the teaching and learning (Park & Ertmer, 2008). Accordingly, behaviours do not change without changes in beliefs (Kagan, 1992; Kane et al., 2002; Ng et al., 2010; Pajares, 1992).

User's beliefs are crucial to attitudes and perceptions

The discussion in this section centres on the beliefs students and teachers have about ICT underpinning the attitudes and perceptions exhibited. Their self-beliefs of ICT are crucial and likely to shape their attitudes towards the use of ICT itself.

Students' beliefs

Today many students increasingly use a full range of 21st technologies to play, communicate, share, support and solve authentic problems. Their beliefs about ICT as being creative and

personally meaningful, profoundly shapes their perceptions of using ICT. This is somewhat encapsulated by Ridgway and McCusker (2008), when they state in part, "ICT are essential for much of modern living" (p. 32), for example, when students perceive "computers are good for the world and real world problems are solved by technologies" (p. 10). These beliefs are likely to shape their perceptions and their own skills and knowledge.

Students form their perceptions of the efficacy of technology in and outside of school (Stefl-Mabry et al., 2010). However, the perceptions students have about ICT may be different when challenged with real world situations, such as commerical and enconomical environments. According to a recent study conducted by the Pew Research Centre (2010), suggests authentically most students compare the technology to which they have access outside school is newer, faster, and far less restrictive than the in-school technology. In such situations students' beliefs are likely to be less favourable towards using ICT within a 'controlled' school environment. This is reflected in a proliferation of literature reviews about students' attitudes and perceptions about ICT in-school use. The significance for ICT in today's students' daily lives has been well documented (e.g. Moos & Azevedo, 2009; Volman & van Eck, 2001).

Teachers' beliefs

Teachers' beliefs about ICT learning are a significant predictor of their attitudes and perceptions towards using ICT, particularly in teaching and learning (Barak & Ziv, 2013). Teachers' epistemological beliefs are regulated by multiple factors such as age, skills and experience, passion or motivation and subject-content knowledge (Heckhausen & Heckhausen, 2008). In order to encourage ICT integration into learning and teaching it is essential to understand teachers' perception of the use of ICT. A large body of research have pointed to the need to distinguish between teachers' ICT-specific and ICT non-specific beliefs (Abbitt, 2011). The former beliefs relate to improving learning processes, better learning success, the promotion of independence, and the diverse benefits of particular ICT functions. Non-ICT beliefs relate to the primary importance of hands-on experience, the risks of isolation in a virtual world, digital over-stimulation, questions about the quality of online media, media-associated disciplinary problems, lack of practicability and lack of priority for using ICT in the classroom (Petko, 2012). Such ICT-related perspectives must be viewed in relation to general epistemological beliefs about knowledge and skills, and teaching and learning (Bruner, 1996; Hofer, 2001).

Accordingly, teachers' persistent beliefs about current practices are recognised as second-order barriers of their attitudes and perceptions exhibited towards using ICT. These are intrinsic factors concerning their beliefs about the nature of knowledge and learning. These beliefs are directly related to performance mediated by cognitive process, motivation, attitudes, behaviour and effort (Schommer, 1990). Schommer has indicated unspoken and sometimes unconscious beliefs about the nature of knowledge and learning play a critical role in teachers' attitudes and perception about ICT itself. That is teachers' self-efficacy of technology skills and knowledge colour their beliefs towards using ICT. So, if a teacher values handwriting, it is unlikely that teacher will positively influence the use of a word processor, because unconsciously the teacher is 'blinded' in the belief about the significance and value of hand written work.

Teacher behaviours are considered an indicator for certain beliefs portrayed in class, such as belief in the value of ICT appropriate to pedagogical practices (Kagan, 1992; Kane et al., 2002; Ng et al., 2010; Pajares, 1992). Thus, if a teacher believes that using ICT itself limits the potential for the delivery of content and pedagogy, then this reduces the likelihood of a decision to implement ICT.

Attitudes and perceptions of ICT skills and knowledge

This section discusses the attitudes and perceptions students and teachers have towards their own ICT skills and knowledge which may affect their perceptions of the value and purposes of ICT use. Students' and teachers' competence, skills and knowledge in activating ICT is crucial to them in their acceptance of the potential and value of such a teacher aid.

Students' attitudes and perceptions of ICT skills and knowledge

Both perceptions of value and self-efficacy concerning ICT skills and knowledge affect a person's use of the technology. Students who are savvy with ICT are likely to be more skillful in performing authentic tasks involving the use of computers successfully (Moos & Azevedo, 2009). Those who enjoy and value using computers pursue activities and academic programs that will help them improve their skills (Dickhauser & Stiensmeier-Pelster, 2003; Selwyn, 1998). In a study by Arras-Vota et al. (2011) they found students trust their competency in using ICT to interact in a learning environment; they believed real-world problems are best solved with ICT.

For most students the efficacy of their ICT skills is clearly demonstrated in their daily activities in schools and at home. As Prensky (2001) states, "digital immigrants on the horizon" permanently connected with digital social media, implies student are born with 'innertness of digital efficacies'. This is how they live, work and play in a digital world; it is second nature to them. Therefore students' attitudes and perception about their own ICT skills and knowledge affect confidence and productive use of ICT in their learning.

In Speak Up reports (Project-Tomorrow, 2014) data has demonstrated students are not just adopting new technologies to use in their learning environments, but are actively manipulating and modifying standard uses for the digital tools to meet individualised learning needs. The types of digital writing provided by ICT are representative of the variety of ways today's students are interacting with digital media and online social sites.

Teachers' attitudes and perceptions of ICT skills and knowledge

Teachers' attitudes and perceptions towards their own ICT knowledge and skills are likely to affect their use of the technology, and likely to affect the attitudes and perceptions of their students use of ICT. Teachers as role models are likely to exert a great influence on students' beliefs about ICT (Aukrist, 2008; Jones & Dindia, 2004). It is often reported by English teachers, frequency of writing is a good first step to improve fluency of writing. But when their belief in their ability and skills relies on using a word processor this would likely enhance students' attitudes and perceptions towards the use of ICT for improvement.

Providing some insight into the issue of teacher preparedness to use ICT for learning and teaching, Granger et al. (2002, p. 487) explain that the "relationship between teachers' ICT skills and successful implementation is complex. The results of their study of schools indicate there is a range of contributing issues, including teacher "attitudes, philosophies, communication, and access to skills training, in addition to having the necessary equipment, support, and education" (p 487).

Attitudes and perceptions towards the value and purpose of ICT use

The attitudes and perceptions a person has towards the value and the purposes they have for ICT will affect their use of the medium (Kagan, 1992; Kane et al., 2002; Ng et al., 2010; Pajares, 1992). Therefore students' and teachers' attitudes and perceptions towards the values and purpose of ICT use is likely to be fundamental to enhancing both teaching and learning (Barak & Ziv, 2013).

Students' attitudes and perceptions towards the value and purpose of ICT use

Students' attitudes and perceptions towards the value and purpose of ICT are crucial to their acceptance of ICT in learning. They believe in the value of greater alignment between their out-of-school learning and that of in-school learning (Bagley & Shaffer, 2009; Shute et al., 2008; Skills, 2008). Therefore, learning in the 21st century is increasingly characterised by the ability to make and understand interconnections between concepts, ideas, and convention across a variety of domains. This often includes greater access to online sites, use of mobile devices and social media, digital tools that help to facilitate need to develop judgement, and discretion, creative thinking, collaboration, and complex problem solving (Burgess & Connell, 2006).

Romeo et al. (2012) found that students perceive ICT has the potential to, and the capacity for, enabling them to construct with purpose, and present their own choice of knowledge from the vast quantity of valuable information available. Students are acknowledging the value of the role ICT as a knowledge-construction tool through collaborative activity. Project Tomorrow (2014, p. 13). found students' perceptions about the value and purposes of ICT is convergent with features and functionalities of these digital tools which should provide them with the means to communicate, connect and collaborate with peers, teachers and experts both at school and at home.

Teachers' attitudes and perceptions towards the value and purpose of ICT use

Teachers' pedagogical beliefs affect their teaching behaviours in the classroom (Bandura, 1986; Clark & Peterson, 1986). With the advent of ICT in education, teachers form their own beliefs about the role of ICT as a teaching tool, the value of ICT for student learning outcomes, and their own personal confidence and competency. If a teacher values the use of interactive digital technologies such as *Inspiration* or *PowerPoint* for presentations, then students are unlikely to use *Butcher's paper* in their activities. Teachers' beliefs about effective ways of using ICT to support learning and achievement is fundamentally dependent on their conceptions about teaching (Cano, 2005). This thought highlights a range of teacher attributes, namely their beliefs, values, culture, age and teaching skills, experiences and knowledge of ICT use. Therefore, teachers' attitudes and perceptions towards the value and purpose of ICT underpin meaningful engagement of students in their learning with the inherent tools. Thus an English teacher believes in the value and purpose of audio-visual technologies in engaging students in the creation of their digital stories (Lim & Hang, 2003).

80

The teacher's perception of competence in creating digital stories encourages students to apply ICT.

Teachers always play a central role in instituting and sustaining changes in classroom practices. However, it has been observed that teachers' intention to change is affected by a myriad of factors, such as their attitudes, beliefs, and school culture (Tay et al., 2012b). These beliefs intersect with their established pedagogical beliefs and can be a 'collision' or 'collusion', both having implications on how ICT is applied in the classroom. It may be an add-on to established pedagogical practices or as a tool that affects change in pedagogical practice (Prestridge, 2007). Some teachers are familiar with traditional teaching methods dating from the time they were students. This is how they learnt, and this is how they plan to teach, as mentioned previously in relation to values in the teaching of handwriting. Teachers are likely to plan and implement practices with technologies that reflect their beliefs about teaching and learning (Drenoyianni & Selwood, 1998).

Jimoyiannis and Komis (2007, p. 597) found, male teachers generally held a more positive attitude towards the value and purpose of ICT in education, while female teachers held a more neutral or negative attitude. Younger teachers had higher confidence levels and were more positive towards ICT in education than senior teachers. The less experienced (those having 1-10 years experience of teaching experience) and the veteran teachers (those having more than 30 years of teaching experience) were positive about ICT in education compared with the highly experienced teachers (especially those having 20-30 years of teaching experience), who mainly held more negative views; this could be attributed to their beliefs about culture, values and tradition.

Attitudes and perceptions towards using ICT in learning environments

This section discusses the attitudes and perceptions students and teachers have towards interacting with ICT in learning environments, and the potential for this integration. As an international phenomenon, ICT is an important part of our everyday lives and efforts to improve teaching and learning (Kim et al., 2013). This suggests that the industrial societies of the past are giving way to a new post-industrial economic order based on ICT as the key fundamentals to modern living. Just as important, efforts to improve teaching and learning need ICT in the learning environment as part of the necessary educational reform (Carnory et al., 1993).

Attitudes and perceptions towards the potential of using ICT in school

Currently national and state policy advocate a digital-rich environment in Australia; equally the education systems across the world feverishly embrased the use of ICT in schools. The rationale to this uptake of ICT is that students will acquire benefits to their learning and ICT skills are becoming a prerequisite for employment.

Students attitudes and perceptions towards using ICT in schools

The place of computers in learning for the majority of students is most likely to occur in the classroom and, for an increasing number, at home (Department of Education WA). Therefore students' attitudes and perceptions of ICT will depend on the nature of their interaction with the technology, this interaction occurring within their learning space at school or in their home. The degree to which students accept the integration ICT into the curriculum may be influenced by a number of factors, their individual learning style preference, previous computing experience and gender being predominant reasons (Shaw & Marlow, 1999).

A student's learning style is a distinctive and habitual manner of acquiring knowledge, skills or attitudes through experience (Curry, 1991). For example, using ICT where video streaming is included may suit some students' learning. Some research has shown that using interactive multimedia increased students' attention, attitudes and interest in their learning (Lehman, 1996; Sanders & Morrison-Shetlar, 2001; Wise & Groom, 1996). Although numerous studies on the relationship between learning styles and the use of ICT have been conducted, evidence remains contradictory. Some researchers (Ellis et al., 1993; Lui, 1994) contend there to be a strong relationship between student style and attitudes to the use of online technology, while others (Hart, 1995) suggest that no such relationship exists.

Most studies show students are positive about using ICT for learning. For example, students employ technology as part of their learning process in schools (Alghazo, 2006) and adopt technology as part of their lifelong strategy (Fco & Garcia, 2001; Pelgrum & Plomp, 1996). Students' positiveness in using ICT ultimately underpins their attitudes and perceptions about the value and feasibility of integrating ICT with learning aids (Schommer-Aikins et al., 2005).

Teachers attitudes and perceptions towards using ICT in schools

Since the introduction of the the Digital Education Revoulation in Australia, teachers are expected to be knowledgable and skill and able to use ICT in the learning environment. Despite this advocacy and expectation, teacher take-up of ICT has been slow and uneven

(Brown & Warschauer, 2006). A large body of reviews have reiterated issues such as time, training, resources and teacher resistance to change being the main delay for the acceptance of ICT in the learning environment. Current views and perceptions of learning determine the way that educational Web 2.0 has driven pedagogy. Teachers need to know, not only how to use the Web 2.0 tools for personal purposes, but also to support students' learning. Web 2.0 has driven pedagogy so that teachers need to know how to use it to support and enhance their students' learning. The use of Web 2.0 is expected to exert a significant impact on teaching and likely to influence teachers' perceptions about providing multiple opportunities for their students' engagement (Dede, 2008; Glassman & Kang, 2010; Mcloughlin & Lee, 2010).

Other research also shows affective issues have a large role to play (Gill & Dalgarno, 2008). These investigations highlighted inadequate teacher preparation as a consequence to employ ICT in schools. Gill and Dalgarno suggest perhaps an 'in-house' teacher role modelling strategy could maximise teacher preparedness in the use of ICT. Wherein offering opportunities for teachers to observe, reflect and employ ICT for learning and teaching. In addition Baskin and Williams (2006, p. 10) suggest those "human factors to be the most critical in nurturing the ICT culture and growing the critical mass of teachers able to sustain the use of ICT effectively in their teaching".

Overall, teachers appear to have a positive, but cautious view of technology in general and of technology use in classrooms. Two general trends emerged in the literature, firstly prior experience with technology is significantly correlated with positive attitudes of teachers; and secondly, teachers' speciality or field of study correlates with their attitude toward technology (Petko, 2012). Similar to Petko's 'will, skill, tool' model, the CBAM model used in this study would elucidates conditions under which teachers would most likely to employ ICT in their classrooms.

From most research findings it appears that teacher influences, such as attitudes and beliefs, have an influence on the integration of ICT into pedagogy. The lack of acceptance of ICT, was also the case for all teachers that had completed ICT professional development workshops. Their level of teachers' technology integration were not all the same, perhaps teachers' behaviours are dependent on their beliefs; as the notion of educational innovation is the result of multiple motives (Mishra & Koehler, 2006).

No doubt, technology has caused significant changes in a number of school practices with teachers always playing a central role in instigating and sustaining those changes in classroom

practices. However, teachers' willingness to change is affected by a myriad of factors, such as their attitudes, beliefs and the school culture (Tay et al., 2012a). Research indicates that teacher professional development is considered as the most effective strategy to promote teacher change for improving student-learning outcomes (Cwika, 2004). But, little is known about the impact of teacher professional development on their perceptions of employing ICT in their classrooms (Forgasz, 2006; Pierce & Ball, 2009).

Attitudes and perceptions towards using ICT in teaching and learning

In contemporary times human life is greatly affected by ICT and how innovation in information technologies influences educational strategies marked by global changes. Students and teachers have perceptions of how ICT could be applied to learning, given the high level of importance ascribed to ICT in current discussions about learning and educational policy (Kim et al., 2013; Masters, 2013; Newhouse, 2013). There is a need to address the reason for so many teachers being so slow to adopt digital technology and, the reasons for so many teachers remaining sceptical about integrating digital technologies into learning environments.

Students' attitudes and perceptions towards using ICT in learning

Students who believe they use sophisticated ICT informally tend to be creative, as in. video-editing. They often have high regard for the potential of ICT in learning. These aspects of ICT capability learnt in the home or through informal contact with peers and others affect perceptions, and are significant in students' construction of their views about the potential of ICT occurring in a learning environment (Eraut, 2000; Schon, 1983). With the potential and power from employing ICT in the learning environment is comprehended students are likely to embrace ICT as part of their learning environment. Students' are more positve towards user-friendly ICT and this usually enhances their perception of technology usefulness for learning. Generally students' attitudes and perceptions about the acceptance of ICT reveal the importance of performance and efficiency as perceived benefits of ICT usage, and motivators for their use in the learning environment (Thomson & De Bortoli, 2012).

Teachers attitudes and perceptions about using in teaching

This section centres around the TPACK framework (Technology, Pedagogy, and Content Knowledge) developed by Mishra and Koehler (2006) TPACK knowledge is likely to determine teacher perception of the potential of ICT in their teaching. When teachers are

knowledgeable in technology use they are likely to use technology in their pedagogical practices. Then productive use of such technologies is likely to further enhance the teaching and learning environment. Technology availability creates the possibility of effective technology integration is typical of such documantation (e.g. Noriris et al., 2003), but knowledge pertinent to pedagogy and content are required to realise the full potential of technologies to improve learning and instruction (e.g. Mishra & Koehler, 2006; Shulman, 1987). Therefore teacher beliefs about their own ICT capability and their employment of the technology are related to their conceptions of teaching, which is imperative to the integration of ICT into the pedagogical practices.

However, studies show many teachers are aware of the potential of integrating ICT use in current practices, but a considerable number of them do so in a traditional, teacher-centred manner, with no significant change in their teaching methods (Barak et al., 2011). Many explanations for teachers' adherence to traditional teaching abound. Lack of familiarity with progressive teaching methods and the time line for efficiently integrating ICT for learning are some of the obstacles. However, the most significant explanation is that teachers' attitudes and perceptions shape the implementation of school reforms in general and the integration of ICTs specifically. Indeed, the integration and the connection because ICT is employed forms a continuous process that calls for changes in teacher's world view (Barak et al., 2011).

After many years of national policy and investment in ICT in the UK and elsewhere, ICT is still an imposed and novel 'outsider' of the pedagogy in schools, according to Kim et al. (2013). However many teachers perceived ICT as a catalyst for change in teaching style, change in learning approaches, and change in access to information.

Despite the availability of computers and Internet connections in all schools, such technology is seldom employed in actual teaching practice (Korte & Husibng, 2006). When it comes to thinking about embedding ICT into pedagogical practice, it is *'the ICT bit'* that is usually given emphasis. Often when teachers are self-assessing their ICT knowledge, pedagogical knowledge is downplayed or ignored.

Most recent literature on pedagogical-content knowledge (TPACK) agree that TPACK is a strong enabler for effective, holistic technology integration in a technological pedagogical environment (Koehler & Mishra, 2009; Polly et al., 2010; Thompson & Mishra, 2008). This TPACK framework builds on the view of Shulman (1987) that Content Knowledge and

Pedagogical Knowledge are inter-woven; thus to the nomenclature, Pedagogical Content Knowledge – PCK and Technological Knowledge (Mishra & Koehler, 2006).

Technological, pedagogical knowledge generally focuses more on developing confidence to solve technical issues as well as developing pedagogical knowledge programs. This could give more priority to teaching the manner of catering for common student understandings and misconceptions while developing capabilities in maintaining a digital learning environment. Hence, attitudes and perceptions will influence the integration of ICT in learning environments (Mishra & Koehler, 2006).

Attitudes and perceptions about assessment

Assessing learning and the method that success or failure at school is reported sends powerful messages, shaping student, teachers, parent and community beliefs about learning. All stakeholders have attitudes and perceptions about the value of assessments and assessment practices.

The next section discusses students' and teacher's attitudes and perceptions of the purposes, validity, reliability, authenticity and efficacy of an assessment.

Perceptions of the purposes of assessment

Fundamentally assessment should be based on its primary purpose - to be of benefit to students (Masters, 2013). The fundamental purpose of assessment is to establish the level of learners in their learning at the time of assessment. The thoroughness and accuaracy of evidence collected from assessments are crucial to students' and teachers' perception of the purposes of assessment (McGaw, 2006). In addition, establishing appropriate assessment processes, effective towards teaching and learning, will follow (Curtis, 2010).

Students' perceptions of the purposes of assessment

Students' perceptions of assessment are underpinned by their interpersonal trust and attitudes towards the value they place on assessments. Their affective variables, states of behaviours, are linked to their perceptions and expectations of the value and purposes of assessment (D'Mello et al., 2009). They perceive assessment outcomes provide them the opportunities to higher or further education as well as gateways to the work force (Denscombe, 2000). Therefore Denscombe contends students show a significant amount of trust in the system to award them the 'right' outcomes. Students' trust and attitudes towards the purposes of

assessment could influence or help them to become more proactive test-takers (Gal & Ginsburg, 1994; Vroom, 1964). The use of standardised testing could influence students' behavioural outcomes, including their study habits and achievement by shaping deep instead of shallow approaches to learning (Entwistle, 1991; Peterson & Irving, 2008; Struyven et al., 2005). Students perceive their trust in teachers and examiners making decisions about desired outcomes, encourage effort to perform on valued activities. Otherwise, there is little incentive to make efforts to perform on certain activities (Pekrun et al., 2002). When students' fear potential failure to foresee the purpose of an assessment, this could create protective self-regulatory responses to dislike evaluative situations and avoid intellectual risk taking, thus obstructing learning.

Teachers' perceptions of the purposes of assessment

Teachers' perceptions of assessment are crucial to how students learn and how their knowledge and understanding grows (Masters, 2013). Their perceptions of the purpose of assessment are likely to influence how they organise their teaching and what students focus on in their learning. This understanding may inform teachers how to improve assessment practices in order to to improve student learning and ease any doubts and fears students may have in relation to about assessments. Addressing these doubts and fears about tests could help students become more proactive test-takers (Gal & Ginsburg, 1994). Thus understanding how students' learning should take into account students' construction of 'reality'. Reality as experienced by students has an important additional value, that is, assessment modes and desirable outcomes. This assumption also applies to students' perception of evaluation and assessment. Teachers believe the purpose of assessment is shown to influence students' behavioural outcomes, but students' perceptions of evaluation methods also play an important role in their study habits and achievements by shaping their varying approaches to learning (Entwistle, 1991; Peterson & Irving, 2008). Students need to trust those who are in charge of making decisions about desired outcomes so that performance efforts on valued activities will be undertaken. Otherwise, there is little incentive to engage in performance effort on certain activities (Hirschfeld & Brown, 2009).

Teachers believe the purpose of assessment should be the collection of students' learning experiences and knowledge over time documenting personal and professional development (Boud, 1990). Teachers perceive that the alignment between curriculum content and assignment tasks would enhance students learning otherwise it will only be rote learning.

Then this unlikely to engage with higher level objectives which may well have been an intended purpose of the assessment (Prosser & Trigwell, 1999). Generally teachers believe students' experiences of assessment do not occur in a vacuum but are contextualised in their overall perceptions of the goals they have to achieve, the workload they carry, the teaching they experience, and the autonomy they have to direct their own learning.

Perceptions of validity of assessment

The validity of an assessment is the extent to which it measures what it was designed to measure, without contamination from other characteristics. Therefore, a test for reading comprehension should not require mathematical ability. According to Masters (2013, p. 38). "All general assessment methods are capable of providing valid information about particular kinds of learning". However, significantly perception about the validity of assessment is construct validity or fitness for purpose according to McGaw (2006).The perceptions of stakeholders are crucial because their attitudes toward the validity of assessment may influence of educational assessments, their affects and consequences, beyond the immediate learning context (Hawkey, 2006). Thus, language assessment/testing in Asia, which is used for decision-making purposes in cases of study abroad opportunities and scholarships (Ross, 2008, p. 6).

Students' perceptions of validity of assessment

Students' attitudes and perceptions about the validity of assessments are crucial to the successful implementation of ICT in assessments (Olariu & Weigle, 2010). Students recognise and perceive assessments involve judgements about the extent to which their performance meets particular standards. In addition, validity of assessment plays a significant role in fostering learning via accreditation (Boud & Associates., 2010). Student learning is related to assessment practices, conversely, students' approaches to learning influence the methods by which they perceive evaluation and assessments. Research findings indicate students to hold strong views about the extent to which they are measured and judged using different assessment and evaluation formats (Struyven et al., 2005).

The manner of student thinking about learning and studying determines the means by which s/he tackles assessment tasks. For example, surface approaches to learning describe an intention to complete the learning task with little personal engagement, seeing work as an unwelcome external imposition. This intention is often associated with routine, unreflective

memorisation, and procedural problem solving with restricted conceptual understanding being an inevitable outcome (Entwistle et al., 2001; Entwistle & Ramsden, 1983; Trigwell & Prosser, 1991). According to Besterfield-Sacre et al. (1998) these beliefs have a profound impact on students' attitudes and perceptions about the up-take of ICT assessments.

Teachers' perceptions of validity of assessment

Generally, teachers believe nothing is gained from assessment unless the assessment has some validity of purpose, based on the adequacy and appropriateness of the interpretations made from the assessments (Messick, 1989). For example, teachers believe the concept of validity applies to all assessments, including performances as a measure of the 'correctness' or 'truth' of inferences made from evaluation results. This implies teachers perceive the importance of interpretative evidence collected from assessments; they expect assessment to measure what it is supposed to measure. Teachers may perceive the validity of assessment to be only about the content, rather than whether it assesses correctly. Messick agrees some of their perceived difficulties in assessment practices represent their past experiences with the 'meaning of test scores'. Scores are a function not only of the items or stimulus conditions, but also of the persons responding as well as the context of the assessment. Therefore, there is a need from the interpretations of the assessment evidence to take into account a person's affective variables, such as perceptions and expectations of value and purposes.

Perceptions of reliability of assessment

In general reliability concerns the desired level of precision in measuring the progress a learner has made over time; relatively precise estimates may be required when measuring national trends in student achievement levels. "The reliability of assessment concerns upon volume of reliable content-specific evidemce collected. Thus, the level of reliability is proportionate to the amount of evidence on which those conclusions are based" (Masters, 2013, p. 5). This implies it is crucial that provisions be made for assessment data to be collected from a range of sources based on multiple pieces of evidence.

Students' perceptions of reliability of assessment

Student perceptions about the reliability of assessment of their work being judged is crucial to achievement in their learning progress (Masters, 2013). Students expect the results of assessment to be trustworthy, stable and consistent, and to deliver the same results on the same test irrespective of when the tests were taken. "They tend to trust examiners to assess

their work fairly, believing them to be professional and well-trained subject experts. However, they might recognise, that some subjects require more interpretation than others, and thus that the reliability of marking could vary. Newton (2005, p. 422) found "students to rarely question the reliability of the assessment process or their assessment outcomes, showing a significant amount of trust in the system to award them the 'right' outcomes". This view could probably be associated to the lack of contextualision of reliability in test scores.

Teachers' perceptions of reliability of assessment

Teacher perceptions of reliability could be interpreted within the context of the reliability of the measurement process (Murphy, 2004). Teachers believe the reliability of an assessment tool should produce stable and consistent results, that is, whether different assessments that employ the same general construct produce similar scores (Henson, 2001; Salvia & Ysselldyke, 1998). Teachers perceive that congruence between reliability and assessment enhances students' academic attitudes and as a result, correlate significantly with their academic achievements (Koul & Fisher, 2006; Reynolds et al., 1995). Teachers' perceptions of assessment reliability are consistent with students' positive attitudes towards academic achievement; they believe the value of their students' academic achievement should be reflected in the assessment of their work.

Perceptions of authenticity in assessment

Authenticity in assessment concerns measuring what is realistic and could reflect such realism of the real world. Thus a task could be a replicate or phototype our society by an engineer. Teachers' beliefs and perceptions of real-world applications aligned instructionally with meaningful tasks. However, most often the reality is that what is taught is reflected in the assessment and bears little resemblance to what is needed (Lane, 2004; Ridgway et al., 2006). Most often this is in stark contrast to the stated intentions of the curriculum content and preferred pedagogy; it does not match the requirements of future study, work or life activities (Newhouse, 2009).

The next section discusses the relationships between perceptions of authenticity and alignment on assessment tasks reflecting the intended curriculum content.

Students' perceptions of authenticity in assessment

Students believe that the authenticity of their performance tasks should be reflected in the decisions made in measurement of their work. For example, assessment tasks should reflect and develop the skills they will need in real world living (Boud, 1995; Dierick & Dochty, 2001; Messick, 1994). Studies show how students perceive the assessment, rather than the actual assessment or teachers' intentions, and are reflected in student learning. Therefore, according to Gulikers et al. (2004). student perceptions of the assessment's requirements influence how they learn and what they learn.

Their perceptions of authenticity in assessment generally includes contextualised tasks and judgmental marking in the assessment. Students perceptions of authenticity of assessments underpin their judgement of the value of doing the assessment. This finding lends support to Gulikers et al. (2008) who documented a gap between student and teacher perceptions of authenticity. Assessment tasks teachers felt were authentic were not considered to be authentic by students. They further suggested authenticity to be a matter of individual perception and somewhat dependent on personal experience.

Teachers' perceptions of authenticity in assessment

According to Linn et al. (1991, p. 11) "Generally, teachers believe authenticity of assessment should align with the curriculum's intended outcomes in order to enhance meaningful judgement of students' performances". Thus, most teachers believe in meaningful outcomes for students' results when the educational decisions were made from authentic assessment data and implemented as intended (McGaw, 2006; Palmer, 2004). For authentic assessment tasks to narrate living it is crucial that the tasks is realistic and examoners to appreciate what real-life situations really concern.

Although assessment methods are capable of providing valid information about particular kinds of learning; it is just as, if not more essential, that its content validity realised, wherein students are learning within their domain of interest, that is, its construct validity or fitness for purpose (Masters, 2013; McGaw, 2006). The two most important reasons for authentic, competency-based assessments lie in their construct validity and their impact on student learning, also called consequential validity (Gielen et al., 2003). Gielen et al. assert competency assessment implies the tasks must appropriately reflect the competency to be assessed; the content of assessment must involve authentic tasks representing real-life

problems of the particular knowledge domain being assessed, and the thinking process used by experts to solve the real-life problem.

Attitudes and perceptions towards the efficacy of an assessment

The efficacy of an assessment according to Bandura and Locke (2003, p. 87) is the "capacity to produce a desired affect through the assessment process, that is, the selection of participants, choice of tasks or instruments and then judgement and data analysis methods". The perceived efficacy of the assessment is likely to involve students' and teachers' perceptions of the value of the assessment task" (Dochy et al., 2014, p. 331).

Students' attitudes and perceptions towards the efficacy of an assessment

It is clear that the more valuable the tasks are, the more likelihood that students will enjoyed the tasks. They are likely to perform these tasks with greater enthusium and passion than the tasks they do not value. Efficacy of an assessment are clearly related to assessment practices how well they can do the tasks, additionally students are more likely to perceive the importance, utility and value of the assessment i.e. and less tendency to avoid tasks they believe exceed their capabilites; because they believe that they are capable of handling the demands (Wigfield & Eccles, 2000). When students are given tasks on which they are likely to succeed, then the resulting success experiences will ensure learning is more pleasurable, increased engagement, self-confidence is built leading to further learning success, they are likely to develop strong self-efficacy (Masters, 2014). This is because they develop beliefs about the importance, utility and value of the tasks that activate self-efficacy. Therefore task value and self-efficacy are both key components for understanding students' choice of assessment tasks in classroom (Wigfield & Eccles, 2000).

Teachers' attitudes and perceptions towards the efficacy of an assessment

Teachers' perceptions of the efficacy of assessment may depend on the importance of the practices. Sadler (2010) believes these practices include the provision of large-scale feedback on summative work to students; however this may be difficult because many students do not learn on a feedback loop because their time for reinforcement may have lapsed (Higgins et al., 2002). Teachers tend to believe firmly in the value of assessment to assist students to learn, even those who present behavioural difficulties or are unmotivated (Berman & McLoughlin, 1977). However, the nature of student achievement, and the nature of educational change, impact on teachers' perceptions of the efficacy of assessment (Petitt, 2011). Masters research

has demonstrated that the identification and measurement of student achievement is highly contextual, depending to a large extent on the perceived importance such data have for improving student learning via the feedback loop (Masters, 2013).

Attitudes and perceptions towards using ICT in assessment

Attitudes and perceptions about employing ICT in assessment are influenced by students' and teachers' views and perceptions of using new generation technologies, such as Web 2.0 applications to communicate, collaborate, support and to enhance learning (Pence, 2007; Underwood, 2007).

In the future, new technologies are likely to have a transformational impact teachers and students in the field of assessment, including the perception of validity, reliability, authenticity and efficacy of analysis, and interpretation and reporting of assessment information (Masters, 2013). The combination of self-efficacy, the value of technology and the interaction with the technology are crucial to the promotion of improved assessment practices.

The following section discusses students' and teachers' attitudes and perceptions as related to the employment of ICT in assessment.

Students' attitudes and perceptions towards using ICT in assessment

For most students the employment of ICT in assessments concerns motivation, concentration and maximum performance (Garrett et al., 2009). Most of them generally perceive technology-based resources to enhance the reliability in measuring performance outcomes (Project Tomorrow, 2014). With a shifting from 'assessment of learning' to 'assessment for learning', emphasis is moving towards integrating assessment with instruction (Masters, 2013). Assessment for learning could provide opportunities for active participation, thereby enhancing students' efficacy of the value of employing ICT in assessment.

ICT use in assessment is exemplified by the integration of e-portfolios into the repertoire of assessment methods. Portfolio assessment, well established in areas such as graphic art education, is now be found in all areas of education, Students perceive portfolios add the important elements of learner-control and long term 'diagnostic' information to supplement other forms of assessment (Redecker, 2013). They perceive digital tools could support their schoolwork, especially those useful in online assessments. Now they are choosing digital portfolios over printed text (Project Tomorrow, 2014); thus their perceptions are likely to

project positively towards the ICT use for assessment, because they believe ICT in assessments can contribute to assessment formats that comprehensively capture their competencies and attitudes towards the process (Ripley, 2009).

Furthermore, for today's students, learning is a daily enterprise, the traditional school day being only a small part of the overall time they spend learning, especially using ICT (Project Tomorrow, 2014). Students found that deploying ICT in assessment tended towards realising elements of 21st century learning, including changes in teachers' assessment practices (Redecker, 2013). This suggests students' positive beliefs towards using ICT in assessment may influence teachers to rethink the value of its facility in assessment for learning.

Teachers' attitudes and perceptions towards using ICT in assessment

It is crucial that teachers have a clearer perception of the significance of ICT and its potential for supporting the assessment process and most educators commonly accepting this notion (Kozma, 2009; Masters, 2013; McGaw, 2006). Masters (2013, p. 46) asserts "teachers believe technology-enhanced learning environments offer a promising avenue for embedded assessment in the more complex and behavioural dimensions of key competencies, based on learning analytics". That is, they allow students and teachers to assess performance, understand mistakes and learn from them. Thus spyware would be loaded openly onto users' computers, thereby tracking the patterns of activity in order to investigate learners' Internet research strategies. Teachers feel that in this way, assessment had been integrated into the learning process, providing powerfully effective motivators for learners. Data analysis could then be used to provide feedback to improve the users'strategies, and to identify areas of future development (Ridgway & McCusker, 2008).

Most literature on educational reform has indicated that teachers perceive technology-enhanced assessment offers catalysts for change to traditional assessment practices and responds to such growing assessment challenges as distance learning, high student populations, objective and high-quality feedback. These outcomes have been supported by researchers (Whitelock & Watt, 2008). Teachers believe the new practices of ICT in assessment are expanding, includinng management and processing of results, learning analytics, tools enabling instant formative feedback, and collaboration on feedback processes (Beevers, 2011). Teachers understand many of these align with the recognition that feedback and assessment should become more deeply embedded within the teaching and learning process (Pellegrino & Quellmalz, 2010; Whitelock & Warburton, 2011).

Teachers accept the value of ICT supported assessments as likely to complement the provision of an effective curriculum employing their pedagogical practices. They agree a better understanding of the potential of digital technologies may broaden assessment methods beyond traditional approaches. While self-efficacy and the interaction with ICT in assessment are crucial, according to a report *The impact of ICT in schools – a landscape review* commissioned by BECTA (2007, p. 63) "it is not sufficient for bringing about students' engagement and attainment. Many other elements need to be present, such as, teacher access to ICT, awareness of how to integrate ICT into teaching practices, and its integration into a whole-school e-strategy". Inherent in the Assessment and Teaching of 21st Century Skills (Griffin et al., 2012) are the four broad categories of skills: ways of thinking; ways of working; tools for working; and skills for living in the world. As such ICT supported assessment has a pivotal role to play in focusing the attention of schools and school systems.

Models for Investigating Perceptions and Attitudes about ICT Use

Many countries around the world in the 1990s were proactively conducting researhes on the application of computers in particular for education. Around this period, (Collis, 1994; Marcinkiewicz, 1995; Sandholtz et al., 1992) instigated models for researching in the implementation computers in schools. Most of these models focused on teachers' concerns about innovations, often called concerns-based models. Most of them evolved from the work of Fuller (1969) on the concerns of teachers as they developed their pedagogical skills. However, the CBAM model has been more fully developed and applied and thus is more often referred to by other models (Hall & Carter, 1995).

The CBAM model has employed successfully in addressing issues such as the effectiveness of using computers to support learning, and why computers have had such little impact on schooling, research is needed on how computer support is implemented and, particularly, on the roles of teachers and students (Newhouse, 1998). The concerns-based models are designed to support research into the implementation of an educational innovation and focus on teachers particularly. According Marcinkiewicz (1995, p. 234) to argues for the use of concerns-based models in educational computing research because to 'understand how to achieve integration, we need to study teachers and what makes them use computers, and we need to study computers and what makes teachers want to- or need to- use them'. The

concerns-based model is equally appropriate to both students and teachers when attitudes and perceptions is the main focus in a reseacch.

Today many models based on Fuller's work used in research with computers in classrooms originated from the CBAM Project at the Southwest Educational Development Laboratory, at the University of Texas (Hall & Hord, 1987; Rutherford, 1990).

The key dimensions of CBAM consists of : Stages of Concern (SoC); Levels of Use (LoU); and Innovation Configuration (IC), the first two being descriptive and the third analytic in nature and scope. Each of the dimensions represent a component of the change process, with SoC and LoU focusing on the implementor whereas the IC reflects the nature of the innovation itself. The SoC and LoU dimensions were developed from the work of Fuller (Hall & Carter, 1995), but the IC came much later Each dimension has associated with it a designated research method and an instrument to collect and present appropriate data. The CBAM requires the researcher to be immersed in the scene of the innovation, continually refining judgements associated with the diagnostic dimensions.

The Stages of Concern (SoC) describe 'how teachers or others perceive an innovation and how they feel about it' (Hall & Hord, 1987, p. 13). It uses a questionnaire with a set of scales to prepare a numerical and graphical picture of the type and strengths of participants' concerns.

The Levels of Use (LoU) identify "what a teacher is doing or not doing in relation to the innovation" (Hall & Hord, 1987, p. 13). It is the sequence users pass through as they gain in confidence and skill in using an innovation resulting in higher levels of use from non-use to institutionalisation. The LoU uses a structured interview and observations to obtain the data needed to place participants at one of these levels.

The Innovation Configuration (IC) "focuses on describing the operational forms an innovation can take" (Hall & Hord, 1987, p. 14). While the SoC and LoU deal generically with the change process from the social-psychological perspective of those users undergoing the change process itself in the context of the innovation, the IC circumscribes the innovation. The IC uses existing documentation about the innovation and interviews with participants, including facilitators, to prepare a two-dimensional chart of the innovation. A series of statements, known as components, are constructed to define the intended outcomes of the innovation. These components are usually listed vertically, must be able to be observed, and represent the innovation implemented fully and successfully. For each component a range of

96

variations representing less than satisfactory implementation are described. Variations are listed horizontally, thus forming a two-dimensional chart.

Most interest appears to be with the *Levels of Use* and *Stages of Concern* dimensions, the user focus, but very little has been reported an *Innovation Configuration*, an innovation focus (Marsh, 1988). Generally two of the three dimensions are used in primary school classes (Carbines, 1986; Hope, 1995). A few smaller studies have also been reported (Overbaugh & Reed, 1995) while a number of researchers in Europe (Vernooy-Gerritsen, 1994) and USA (Marcinkiewicz & Welliver, 1993) worked at modifying the SoC and LoU to describe the use of computers in classrooms by teachers Moersch (1995) constructed instruments to measure the LoU of a teacher or class. Typically, the models and instruments have developed around large projects to place computers in schools. The model is relevant to the present study as it provides a method of investigating the digital forms of assessment innovation regarding the concerns of teachers and students within a learning environment context.

Conclusion from Review of Literature

An extensive literature review was carried out into performance assessment, computer-based assessment and attitudes and perceptions in human-computer-interaction. The following summarises the main points that provide a foundation for the theoretical framework.

Currently requests for improved evidence to inform decisionmaking have placed new expectations on educational assessment. Performing a task in practical learning activities profoundly influences the application of knowledge and deeper understanding. The use of problem-centred approaches to assessment of practical performances in fostering deeper understanding is well supported in the literature (e.g. Binkley et al., 2012; Clarke-Midura & Dede, 2010; Griffin et al., 2012; Lai et al., 2008).

Computer-based assessment makes possible support for all assessment processes from providing assessment tasks to marking, reporting and feedback JISC (2006, p. 6). It provides more authenticity in assessment strategies that go beyond testing factual knowledge and the capability of capturing the authentic themes supported by digital technologies (Masters, 2013). Hence, he states it better harmonises with the 21st century learning approaches by providing timely and the meaningful feedback to both learners and teachers is fundamental to teamwork, innovation and information sharing in the learning environment.

Human-computer-interaction is a means of connecting people in their workplace, home or on the move. Advances in digital technologies will enable programs to encompass the interaction between human and computer performance, and progress towards assessing educational growth, predicting future performance, and revising curricula and assessment strategies (Johnson et al., 2011). Digital technologies and digital forms of assessments could possibly enhance human-computer-interaction and progress towards greater understanding of learning and the development of a broader range of life skills and attributes (Masters, 2013; Redecker & Johannessen, 2013; Richardson et al., 2002). In addition, assessment reform has arisen for research into such learning itself, as the understanding of basic learning processes, impediments to learning and the conditions supporting the degree to which successful learning has continued to develop over recent decades. Masters (2013, p. 3) contends research, such as "cognitive science and neuroscience, has played a significant role in human-computer-interaction. One insight refers to the understanding of the 'science of learning' or the brain's plasticity, which is likely to be freed of constraints by current technological capabilities, thus giving rise to human-computer-interaction".

It is likely new technologies could have a transformational impact on teachers in the field of assessment, including their perception of validity, reliability, authenticity and efficacy of the analysis, interpretation and reporting of assessment information (Masters, 2013). The vision for computer-based assessment has been advocated in current research studies, calling for a pedagogically driven model rather than one of technology, with a standards led framework looking towards future developments in this area (Whitelock & Brasher, 2006). A report from OECD (2001 p. 9) states that "The ubiquitous presence and utility of ICT in the future is likely to have profound implications for education" and implies that it would fundamentally be a student-centred learning environment and more reflective. Embracing more 'on-demand testing' to assist students to realise their own potential and construct digital portfolios to assist in the presentation of themselves and their work in a more 'personalised' manner.

Conceptual Framework for the Study

The key concepts and relationships drawn from the literature are represented in a theoretical framework (see Figure 2.1) which shows the researcher's diagrammatic representation of the different components and elements within the Learning Environment, and which complement

the main project. From this framework ideas will develop leading to the measurement of perceptions and attitudes critical to answering the research question.

The assessment process for the purposes of this study could be viewed as consisting of five components:

> 1) the assessment task (what the learner does);
>
> 2) the task assessment (what the assessor does);
>
> 3) performance assessment indicators (parameters of assessment);
>
> 4) institutional goals and outcomes (quality control, training and support); and
>
> 5) management and administration (what the stakeholders do with and how they receive the feedback and results).

Central to this study was the concept of assessment of student performance. In particular the component of assessment task, that illuminates what the learner does. The student work, task or object involves creating digital forms deploying audio-visual recording, graphics images, animations and text. This will ultimately determine the appropriate means and methods from digital portfolios, computer-based exam and audio-visual recording of assessments using ICT. Therein their attitudes and perceptions towards the employment of ICT to support assessment and learning will be revealed as being crucial to the success of embedding digital forms of assessment in the learning environment.

A component of task assessment is 'what the assessor does'; it is determined by the purpose and type of assessment task, that is, the methods of assessment and means of assessing learning. Marking methods require marking criteria, rubrics, key and guides, and trained assessors with prerequisite skills and knowledge. They need this knowledge for application of the marking criteria to the chosen marking activities with sufficient precision to meet the required standards for the course.

Assessment indicators must be amenable to assessment quality which is in general fair and fit for the assessment task's purpose, including validity, authenticity, transparency and equity. "An assessment process should bias free, that is balance and fair and not dependent on variables such as gender, physical disability, cultural background or geographical location" Masters (2013, p. 41).

The components of this framework will be discussed next. They will draw on the ideas discussed in the preceding review of the literature. The conceptual framework was developed to underpin this study. Therefore, concepts and relationships of the *assessment* component may be viewed in relation to the five components via: *assessment task, task assessment, assessment indicators*, *institutional goals and outcomes,* and *management and administration.*

The 'Learning Environment component' of this theoretical framework encompasses Teachers and Students perceptions and attitudes about the employment of ICT to support assessment and pedagogy; it was the focus of this study, to share relevant innovations and add new knowledge. The larger main study 'Investigating the feasibility of using digital representation of the work for authentic and reliable performance assessment in senior secondary courses'. It formed part of a larger research headed by Dr Paul Newhouse of ECU and focused mainly on using digital representation of work for authentic performance assessments. This study provided an extension to the larger study by researching students' and teachers' attitudes and perceptions of digital forms of assessment. This is consistent with the (JISC, 2006, p. 43) report that states "Assessment embodies what is valued in education; it sets the educational outcomes whether they be in the form of examinations, qualifications, tests, homework, grading policies, reports to parents or what the teacher praises in the classroom. The focus of assessment might be any of participants within the assessment process: learners, teachers, school managers, assessment providers, examiners, awarding bodies"

This study was concerned with students' and teachers' attitudes and perceptions about the employment of ICT to support digital forms of assessment and pedagogy. The Learning Environment component focused on the affective domain: teachers' attitudes and perceptions about the employment of ICT to support performance assessment. Equally important in this study is provision of digital forms of assessment that are authentic, valid, reliable, fair and comparable. The purpose of the assessment is critical to all aspects of the design and implementation of the assessment tasks and to the process of task assessment. The type of assessment should meet the assessment quality guidelines and must be amenable to reliable marking. For this study, summative/qualitative assessment was the chosen type, that is, "digital portfolio and a computer-based performance exam" (Newhouse, 2011), to reflect the context of real world situations which enhances higher order thinking, creativity and understanding of performance-based task assessments.

Assessment quality refers to not only to the reliability of the marking process, for whatever the type of assessment chosen, it must be amenable to reliable scoring, but also to general fairness and fitness for purpose of the assessment tasks. These properties of assessment quality are typified by validity, authenticity, transparency and equity. The score is inextricably linked to the perspectives of the stakeholder in the assessment process. Teachers are also important stakeholders but for them the purpose of assessment is to provide feedback on their teaching which leads to evaluation of method and possible improvement. For students, assessment is a primary factor in their motivation to study with the score awarded providing feedback, diagnosis and motivation towards further study.

While assessment is a necessary element of any education, learning environment, it is not sufficient for bringing about students' and teachers' positive beliefs in the employment of ICT to support assessment and learning. A number of compelling reasons are given as to the reasons stakeholders in the management of institutions should consider a framework for a technology-enabled assessment. For example, recent developments in large-scale e-assessment policy and practice in the UK discussed the ways in which schools can use technology and assessment to support and transform learning in the 21st century the positive effect on motivation and performance was discussed. Adult learners self-labelled as school and exam failures have said that e-assessment removes the stress and anxiety associated with traditional approaches to examinations (Boston, 2005). In addition, the Learn2Go project in Wolverhampton and e-Scape in Kimbell have experimented with the use of handheld devices in primary and secondary schools (Whyley, 2007). "These projects have demonstrated significant improvements in children's self-assessment, motivation and engagement with the curriculum, especially in reading and mathematics. The project now claims to have evidence these broad gains translate into improvements in children's scores on more traditional tests" (Scheuermann & Pereira, 2008, p. 25).

The ability to deliver and capture student assessment performance in digital forms has many potential advantageous implications. These range from "doing traditional things in new ways, to extending what we could traditionally do, and onwards to supporting digital forms of assessment and learning in new ways" (BECTA, 2006, p. 3).
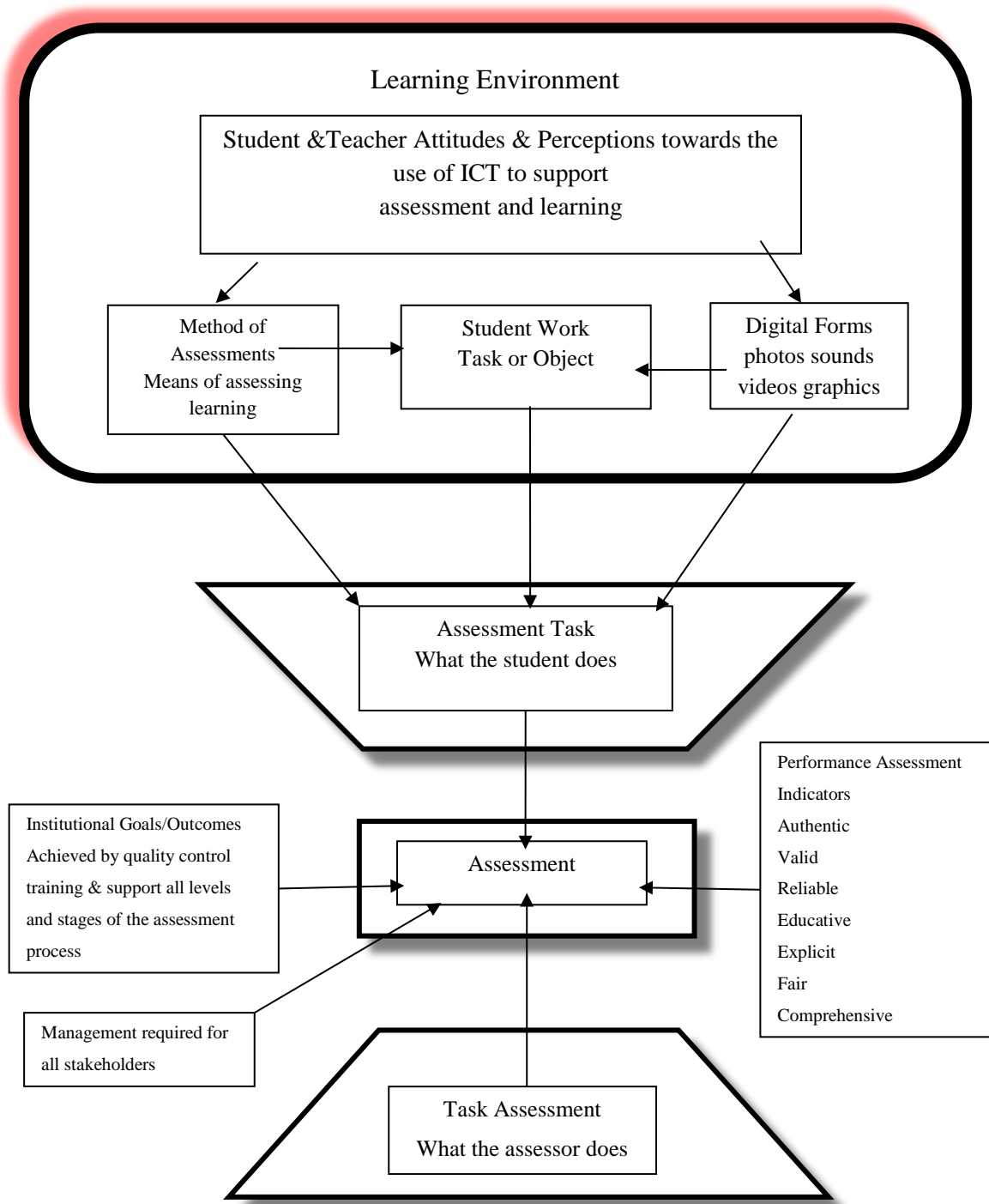
Figure 2.1 Schematic diagram representing the conceptual Framework for the study

Statement of the Research Questions

The main research question was:

In what ways do the perceptions and attitudes of teachers and students towards the use of ICT
in learning affect the feasibility of using digitally based representations of student work

output on authentic tasks to support summative performance assessments for the Engineering Studies and AIT WA courses?

This will be done within the context of the main study and will consider a number of subsidiary questions.

(1)   What similarities and differences occur in student and teacher perceptions and attitudes towards ICT in assessment between AIT and Engineering courses?

(2)   What effects on the feasibility of digital forms of assessment do differences in student attitudes and perceptions in AIT and Engineering?

(3)   What are the attitudes and perceptions of teachers towards the use of digital forms of performance summative assessment using criterion-referenced marking?

The next chapter will focus on the research methodology, discussing the samples and data sources employed with explanations of analysis and interpretation of these data. The chapter concludes with a discussion of the context for the research design, scope, method and data collection and analysis.

Summary

This chapter has examined some of the literature relating to performance assessment, computer-based assessment, and students' and teachers' beliefs of ICT and assessment. Beginning with an overview, the chapter progressed to those specific aspects of each discussion which have direct bearing on the study. A theoretical framework was generated to guide the methodology, data analysis and interpretation for the study. The next chapter will describe the design and method of research, the participants, assessment tasks and data collected.

CHAPTER THREE:
METHOD

This chapter describes the research method, including descriptions of the samples and data sources used, with the explanations of analysis and interpretation of these data. The context for the research design, scope, method, data collection and analysis for the study is discussed. The method in this study, being part of the larger research study, used a quasi-ethnographic mixed method approach with a feasibility framework for analysis. The methodology applied also included the use of the Concerns Based Adoption Model (CBAM) (Hall & Carter, 1995). CBAM has been utilised in a variety of studies internationally and is regarded as 'a powerful tool for diagnosing the implementation effort's progress' (Ellsworth, 2000, p. 43). These two analytical frameworks are discussed at the conclusion of this chapter.

The rationale for the method, which was given in Chapter One, emerged from the main research question and current thinking about conducting research on ICT supported pedagogy and the affect of teacher and student attitudes and perceptions.

Background to the Research

This study supported and built upon the research in a larger study by aligning with a component of that study. It was designed to leverage off this larger study that investigated digital forms of assessment in WA. The larger study's research questions focused on the implementation of assessment tasks and marking. It concerned feedback on the tasks from students and teachers but did not specifically investigate their attitudes and perceptions towards employing ICT in assessment.

The present study focused on two of the four courses addressed by the larger study AIT and Engineering Studies, and the summative assessment tasks in the second phase or year of the larger study. The overall aim was to design, develop and implement the best assessment task possible to measure the practical performance of students in Engineering Studies and AIT. To evaluate the feasibility of this task, the study gathered data in various forms from a wide variety of sources. Data were assembled from observation and discussion with teachers before, during and after schools visits, from student survey and from teacher interviews responses. Small groups of students were assembled into discussion forums and responses to a series of questions were recorded and analysed. The research added knowledge concerning

the attitudes and perceptions of teachers and students towards moving from paper-based assessment to digital forms of assessment in these two courses. Both courses had a practical performance-based component in their curriculum but it was the assessment of aspects of this that was targeted.

The AIT course was selected because at least two of its outcomes were directly related to the production of digital materials; thus students and teachers were likely to have adequate competence in the emplyment of ICT. Therefore it was considered that a range of digitally based forms of assessment could be readily implemented. The Engineering Studies course was selected because it was a completely new course and its outcomes included processes and practical performance that would not be adequately assessed using paper-based forms.

The focus of this study was on student and teacher attitudes and perceptions towards the employment of ICT to support summative performance assessments in the Engineering Studies and AIT senior school courses. This study aligned with the larger study and provided further meaning to its findings.

Description of Assessment Tasks and Technologies

As background to the present study this section presents the digital forms of assessment implemented in the Engineering Studies and AIT classes, and the technologies associated with these assessments. The Engineering Studies assessment was a 3-hour computer-supported production exam involving the design and modelling of a solar, water filtering system. There were two assessments for AIT, a computer-based production and performance tasks exam and digital portfolio. The latter was completed in class time as a project prior to the exam.

Engineering Studies assessment task

The Engineering Studies design task was developed in consultation with teachers of the course. The elements of the task concerned a series of specified activities taking the students from a design brief to the construction and evaluation of a model over a period of about 3 hours. Each activity was timed so all students had the same specific time frame in which to complete each activity. The e-Scape exam management online system was deployed to deliver the tasks to the students, manage the exam time, provide tools to complete some of the tasks, and collate the evidence of performance into a portfolio.

106

The e-Scape system was implemented either through the Internet directly to the MAPS server in the UK using the schools' local area network, or set up using an Intranet wireless router, a local laptop server and a set of Asus EeePC netbooks. This was appropriate and suited the structure for the assessment tasks which included text, graphics photographs voice and video files. This enhanced and facilitated the peer-sharing modelling component of the assessment. Students' outputs from assessment tasks were compiled into individual portfolios each of which was indexed for easy access and identification. Although different technologies were used for the examination, depending on whether the 'Intranet' or the 'Live' process was used, the appearance of the assessment tasks presented to students were similar on both systems.

Students who used the Intranet method were issued with Asus EeePC netbook computers which were wirelessly linked with the research facilitator's laptop computer. The facilitator monitored each logged-in student's progress throughout the assessment tasks and stopped or extended a task if necessary. The examination of three groups in two schools was conducted this way. The activities of the examination were uploaded progressively either to the facilitator's computer or directly into the server. Each student used a computer, either a desktop or a laptop model, provided by the school or a netbook computer similar to those used by the research team. The total length of time required varied from class to class as a break was taken at some stage between activities the length of the break varying. Input from students consisted of text and graphics using keyboard and mouse, photographs, voice and video through a web-cam and microphone. Students' inputs were automatically stored in the MAPS online portfolio system.

Students who used the school's workstations were connected to the local area network and logged on 'live' to the MAPS examination server. The examination of four groups in three schools was conducted this way. Students using the local area network set up on a wireless router were logged onto the intranet local laptop server with a set of EeePC netbooks.

For both methods, live or Intranet, the researcher or a member of the research team coordinated the activity by controlling the sequence of tasks either via one of the school's computers or a laptop server connected to a wireless router. This was the mechanism for managing the set time students had on each activity, or prompting the students to move onto the next page of their portfolio at the appropriate time. The running sheet is provided in Appendix O.

AIT assessment tasks

There were two assessment tasks: computer-based production exam; and a digital portfolio which students completed in class time as a term project. The AIT assessment tasks and details related to their development and components are provided in Appendix L.

Digital portfolio

The digital portfolio was a reflective-process portfolio that included a digital product, a collated process document associated with the digital product, and two additional digital artefacts. Students completed the digital portfolio over a period of sixteen hours during four weeks of normal class activity. However, the intention was for the two additional digital artefacts to have been created previously as part of their course work, to demonstrate ICT skills and knowledge different from the product developed during the sixteen hours.

The final product was a creation of a prototype of an information solution in the form of a digital product relevant to a challenge or problem in a business context, using applications of software commonly used in organisations for productivity, planning and communication, for example, standard office type software. The challenge or problem was presented in a default design brief, but teachers could edit this to be a different challenge or problem felt to be appropriate. It was recommended the product must have been produced at school using hardware and software provided by the school and represented no more than sixteen hours work over a maximum period of four weeks, and not to exceed 20MB in digital size.

The process document concerned the design brief associated with designing the digital product and two additional artefacts. This process document allowed students to explain the technology process used in the planning of the digital product. The technology process consisted of a cyclic model of Evaluating, Designing, Producing and Appraising. The additional artefacts' component allowed students to illustrate their skills in applying design principles to graphics, databases, spread sheets and/or web publishing. The digital artefacts' submission included a document of no more than one page in length describing for each of the two artefacts the hardware software techniques and skills needed to create the artefacts.

The final submission of the portfolio consisted of text, voice, sketches and pictures or videos. This collection of work was organised according to the specified parameters such as form, structure and range of samples for the portfolio. A storyboard template was to be developed for students to their ideas on paper to include in their portfolio. Students were allocated an ID

number at the time their USB thumb drive was issued. This number identified their portfolio, sketch sheet and model and ensured their anonymity. The submission of the digital portfolio components was uploaded into an online MAPS portfolio system. This web based database was the respository for collation of all students' digital work.

Computer-based exam

The computer-based exam involved students designing, producing and evaluating a poster or interactive presentation associated with a real-world design brief, being prompted to follow the technology process in creating a digital product. The exam comprised a set of short tasks associated with this common design brief scenario and set for two hours using a desktop computer and standard office type software. The focus was on commonly used ICT applications in a business context with students designing an information solution for the problem specified in this context. The design brief challenge was to elicit ideas in presenting information in the form of a promotional shopping centre display about the students' school to the local community. The format display could be either an interactive display or a poster, both options required text, images, a video and a feedback format. Students were provided with the resources for creation of their choice of display at the beginning of the exam. Overall the aim for them was to be as open as possible to allow a variety of prototype products, but structured to support the same process and time frame for all students.

Students were given a paper copy of the exam and a 4GB USB flash drive containing resources needed for the design brief. An audio headset with microphone was also provided. With the exception of design sketches, which had the option of being paper or computer-based, the entire examination was completed on computer. Student responses to the exam were saved as digital files in various formats on the 4GB USB and a copy was uploaded to the MAPS online portfolio system when the exam was completed.

Research Design and Scope of the Study

The study was evaluative in nature, set within an ethnographic framework in that the activity occurred within learning environments wherein the characteristics of teachers and students and the culture created, were critical to an understanding of all aspects of the curriculum and pedagogy, including assessment. The research design complemented and shared some innovations of the overarching project.

The main characteristics of student and teacher attitudes towards, and perceptions of, the use of ICT in assessment were investigated. It involved the teachers and students from five schools in each of the two courses being the second year of the larger study. The focus was on the implementation of summative assessment tasks in each of the courses.

The main research question focused on the students' and teachers' perceptions and attitudes about the emplyment of ICT to support digital forms of assessment. Together with the three subsidiary questions, which discussed similarities and differences, effects of the feasibility of digital forms of assessment on students' attitudes, and perceptions of teachers towards the use of digital forms of performance summative assessments. These subsidiary questions provided the scope of this study within the context of the overarching study.

Research Method

The methodology for this study was quasi-ethnographic mixed method research, using data from observations, interviews, surveys and literature reviews. The study combined quantitative methods of a student questionnaire, and the qualitative methods of class observations, student interviews, and a pre- and post-interviews with teachers. These methods were chosen because they were appropriate for a participative-action research methodology, providing a platform for the researcher to be actively involved in the process of collecting quality data.

The research design for the overarching study was described as participative-action research evaluation with participants contributing to development through evaluative cycles. This study was set within one of these cycles. This required an analysis of the perspectives of the key groups of participants, both students and teachers,with data collected from each group. These data were compiled into case studies within a multi-case approach (Burns, 1996) in which each case was defined by one digital form of assessment in one class for one course. This allowed for refinement and further development of findings based on multiple instances of the same phenomenon under different conditions. Whenever possible throughout the study, the researcher made an effort to gather multiple perspectives through multiple sampling points which enabled triangulation of the data gathered (Marshall, 1997) and cross-checking that improved reliability. Therefore, this study largely employed interpretive techniques involving the collection of both qualitative and quantitative data.

The two overarching analysis frameworks used for the study were the Concerns Based Adoption Model (CBAM) (Hall, 2010) and the e-Scape project Feasibility Framework (Kimbell et al.). A CBAM was employed to provide clarity into the implementation of ICT to support assessments for these two courses. The three constructs IC, SoC and LoU of the CBAM analysis were deployed specifically with data from the two teacher interviews to map the implementation of digital forms of assessments. The four dimensions of the e-Scape Feasibility Framework (i.e. Manageability, Technical, Functional and Pedagogic) were deployed to interpret data collected from students, teachers, course consultants and other professionals, and is presented in Table 3.5.

Samples

The samples comprised teachers and students from the Engineering Studies and AIT courses in Year 11 in Western Australia, in 2009. The Engineering Studies samples consisted of students and teachers from two private and three public metropolitan secondary schools. The number of classes, students and teachers for each school are shown in Table 3.1; there were a total of five schools, 84 students and six teachers. The AIT samples consisted of students and teachers from one private and four public metropolitan schools; there were a total of 95 students and five teachers (refer to Table 3.2).

Table 3.1
Engineering Studies data sample

School	Sector	Class	Students	Teacher
GE	Public	1	15	1
HE	Public	2	21	2
LE	Public	1	20	1
RE	Private	1	23	1
*WE	Public	2	16	*1
Total		7	84	6

*Note: WE school had two classes, each timetabled on a different day with the same teacher

Table 3.2
AIT data sample

School	Sector	Class	Students	Teacher
NA	Public	1	15	1
OA	Public	1	21	1
VA	Public	1	20	1
XA	Private	1	23	1
ZA	Public	1	16	1
Total		5	95	5

Data Collection, Instruments and Analysis

This study made use of the data collected for the main study by adding to the analysis of these data to address the research question within its context. The overarching study collected a range of data including: digital work output; other assessment data; observation of assessment tasks; student and teacher questionnaires, and student and teacher interviews. This study added questions to the questionnaires and interview protocols with particular focus on students' and teachers' attitudes towards and perceptions of ICT to support digital forms of summative assessments both for Engineering Studies and AIT courses. Specifically, a pre-task teacher interview and questions in the post-teacher interview were added to accommodate the CBAM analysis.

This research deployed a wide range of data sources and associated instruments, both from the qualitative and quantitative traditions of research, to gather data over a year. The main data sources were student surveys, student forums, classroom observations and structured teacher interviews. Other sources were teaching documents, school timetable, initial school visits prior to the assessment, and informal conversations with teachers. Most of the structured

interview questions and paper-based questionnaires were developed for the study to address the main research question, which concerned students and teacher's attitudes and perceptions towards ICT to support assessment and curriculum pedagogy.

The quantitative and qualitative data derived were analysed independently for each class, being compiled into case studies and then combined. Data were analysed using a constant comparative approach looking for themes, trends and developing rich descriptive accounts (Patton, 1990). Triangulation of data types and sources enhanced the credibility of findings. Each of the sources of data and analysis approaches, are discussed separately as follows.

Teacher Interviews

Teachers in the study were involved with two structured interviews, one before the day their students started the assessment, and one after students had completed their assessment. For AIT students this included a portfolio as well as an exam. The first interview consisted of ten questions; and the second of eleven questions. The interviews were conducted by emails, phone or in person using the Teacher Interview questionnaires provided in Appendix G.

The initial teacher interview was designed to ascertain teacher attitudes and perceptions towards the efficacy of ICT in supporting digital forms of assessment in the course with their class/classes. It was also an attempt to gauge teacher experience and their involvement with the application of ICT to assessment and learning. The data derived were specifically mapped against the three CBAM constructs IC (Innovation Configuration), SoC (Stages of Concern) and LoU (Levels of Use) to gauge teachers' levels of access and use of ICT to support assessment and learning. CBAM constructs are listed in Appendices A, B and C.

The post-teacher interview was designed to elicit attitudes and perceptions about the assessment their students completed in the study and the efficacy of the assessment task. These teachers were asked how they felt about the structure of the assessment tasks and their students' reaction to the activities. The interviews were also seeking their objectives and perceptions about ICT in supporting pedagogy in their classrooms. This provided an opportunity for them to reflect upon and comment on the potential for ICT supported assessments for their course and for other subjects. It was also crucial for this study as it further validated the appropriateness and relevance of ICT use for performance-based courses across the curriculum.

Teacher comments and suggestions were noted during the observation visits. They were asked to share their views and experiences pertaining to the nature, organisation and delivery of the tasks, these forming part of the field notes for each case. The results of each teacher interview, as well as the recording in note form obtained at each visit, were summarised and added to each case study.

The data from these teacher interviews were analysed and transcribed within the context of the main study; had been extended in the questionnaire and interview protocols to accommodate the CBAM analysis. The focus in this component of the research was on teachers' attitudes about ICT use to support digital forms of summative assessment for both courses in Engineering Studies and AIT.

Classroom Observation

The researcher visited Engineering Studies and AIT classes involved in this study two or three times on different days to gather data. These observations included students at work on the assessment tasks, both on digital portfolios in the case of AIT, and the computer-based exam for AIT and Engineering. The final visit also included facilitating the student survey and the forum. Observations of each class of students in the process of completing their assessment task used a structured approach to address the manageability dimension of the feasibility framework. These data assisted in interpreting results from other data, particularly regarding the constraints associated with the realities of conducting these assessments in schools. Classroom observations were conducted either by the researcher and/or one of the research team members. Notes were written or recorded during observation periods and were verified by the participating teacher as soon as possible after the observations. On some occasions photos were taken of the classrooms/labs.

Student Survey

Questionnaires were employed to collect data on individual student's characteristics, including perceived level of ICT skills and experience, and their experience of the assessment task. These data were used to address all four dimensions of the feasibility framework and contribute to the CBAM analysis. They also provided information on the students' use of the computers at home and school, the perceptions of teachers and students concerning the assessment for the course, and students' computer-related attitudes, knowledge and skills. The student surveys were designed to collate data on how students' felt and what challenges they

experienced in completing the assessment tasks, and generally, their thoughts about what they would like to achieve through ICT in supporting their assessment during their courses. They also provided insights into the constraints associated with the realities of conducting ICT supported assessments in schools.

The Engineering Studies survey questionnaire consisted of 58 closed-response items and two open-response items; the AIT survey questionnaire consisted of 66 closed-response items and four open-response items. However, the AIT questionnaire had more items to account for employing two forms of assessment. These were the standard questionnaires used in the larger study and were derived from previous questionnaires deployed in CSaLT projects, and the e-Scape project (Kimbell & Pollitt, 2008). The questionnaires are included in Appendix F.

The closed-response items were classified, numerically coded for entry into a spread sheet and SPSS. The data were analysed and descriptive and frequency statistics were generated. The open-response items were recorded and classified to assist in seeking themes and trends thereby developing rich descriptive accounts (Kimbell et al., 2007). A selection of the most common themes for 'the best' and 'worst things' were identified and developed for validation and triangulation with data type and sources. The transcripts are listed in Appendices D and E.

Scales from survey items

For Engineering Studies six descriptive scales were constructed from sets of closed-response items in the survey questionnaire. Some of the items were reversed in order to highlight the most positive response. Descriptors of the scales are provided in Table 3.3. For AIT seven descriptive scales were constructed from the sets of items in the survey questionnaire. Descriptors of the scales appear in Table 3.4.

Table 3.3
Engineering Studies descriptive scales

Scale	Description	Items	Score	
			Min	Max
eAssess	Efficacy of the Engineering exam.	All items in E2.	1	4
Apply	Application of computer uses.	All items in Q10	1	3
Attitude	Attitude towards using computers.	All items in Q11	1	3
Confid	Confidence in using computers.	All items in Q12	1	3
Skills	A measure of ICT skills.	All items in Q13	1	4
SCUse	Time (mins) per day spent using computers at school.	All items in Q8	0	360

Table 3.4
AIT descriptive scales

Scale	Description	Items	Score	
			Min	Max
eAssess	Efficacy of the AIT exam.	All items in E2.	1	4
eAssessP	Efficacy of the digital portfolio.	All items in P2	1	4
Apply	Application of computer uses.	All items in Q10	1	3
Attitude	Attitude towards using computers.	All items in Q11	1	3
Confid	Confidence in using computers.	All items in Q12	1	3
Skills	A measure of ICT skills.	All items in Q13	1	4
SCUse	Time (mins) per day spent using computers at school.	All items in Q8	0	360

The analyses of all data, whole sample, and case studies were generated mainly from SPSS to obtain descriptive statistics for the scales and graphs to show the distribution of scores. Cronbach's Alpha coefficients were used to check the reliability of the measures and effect sizes were used to compare the means.

Effect Size

An effect size is a simple way of quantifying the difference between two groups. Effect sizes are calculated by computing the difference between means, divided by the pooled standard deviation. This is a scale-free descriptive measure of the separation between groups' means. The results provide a known benchmark, that is, a range of effect sizes small, medium and large between the group's means. It is easy to calculate, readily understood and can be applied to any measured outcome in education. It is particularly valuable for quantifying the

effectiveness of a particular intervention, relative to some comparison, that is, attitudes and perceptions in this study. Furthermore, it allows the researcher to move beyond the simplistic, 'Does it or not?' to the far more sophisticated, 'How well does it work in a range of contexts?' Moreover, by placing the emphasis on the most important aspect of an intervention, the size of the effect rather than its statistical significance which conflates effect size and sample size, it promotes a more scientific approach to the accumulation of knowledge. For these reasons, effect size was and is an important tool in reporting and interpreting effectiveness when summarising findings of attitudes and perceptions.

The justification and appropriateness of using 'effect size' in ICT intervention was also endorsed in findings of other scholars (Patton, 1990), wherein effect sizes between 0.25 and 0.5 were considered to be large enough to be educational and practically significant.

Student forum

A stratified sample of four or five students in each case study was identified by each teacher to participate in the forum. The discussion forums were semi-structured discussions being recorded in digital and/or note form (Kim et al., 2013; Koehler & Mishra, 2009). The researcher conducted the forum as immediately after completion of the exam as possible, often on the same day. The combination of notes and, in some cases, audio and video recordings provided a complete record of the results of the student forum. This was transcribed and then summarised (see Appendix D).

The forums were structured to elicit students' feelings, experiences, attitudes and perceptions about the assessment tasks, that is, digital portfolio and exam, for AIT and the exam for Engineering Studies. This forum enabled students to reflect collectively to establish a general consensus on how they perceived the manner in which the assessments were conducted. It provided and opportunity for them to express their feelings about other dimensions so enabling the researcher to validate triangulation for descriptive purposes. In all these forums assisted in interpreting the students' attitudes and perceptions towards the assessment.

Analysis of Data for Each Case Study

The discussion in this section focuses on the measurement of attitudes and perceptions which was critical to answering the research question in this study, concerning 'student and teacher perceptions of, and attitudes towards, the use of ICT to support digital forms of summative

performance assessment." The two overarching analysis frameworks were used for each case study when addressing this research question.

Feasibility Framework

The larger study used a feasibility framework adapted from the e-Scape project (Kimbell & Pollitt, 2008). The framework comprises four dimensions: Manageability; Technical; Functional and Pedagogic. Descriptions of the dimensions and the data used to address each are given in Table 3.5. The larger study was concerned in detail with all four dimensions; this study less concerned with such a functional dimension as marking. All dimension were concerned about the perceptions of students, teachers and the researcher.

Table 3.5
Feasibility framework for analysis of task assessment data (Newhouse et.al., 2008)

Dimension	Description	Types of Data Collected
Manageability	Concerning making digital forms of assessment do-able in typical classrooms with the normal range of students.	Observation, student forums and surveys, teacher interviews.
Technical	Concerning the extent to which existing technologies can be adapted for assessment purposes within course requirements.	Deliberations with Advisory Group, consultants and other professionals.
Functional	Concerning reliability and perceptions of validity, and the comparability of data with other forms of assessment.	Interviews with teachers and assessors, quality of digital representations.
Pedagogic	Concerning the extent to which the use of a digital assessment forms can support and enrich the learning experience of students.	Questionnaires and interviews with teachers and students.

Manageability dimension

This dimension was concerned with whether teachers could organise the assessment tasks in a typical teaching space, while effectively managing time and resources available for the assessment tasks. Considering whether teachers could manage students' workflow, for example, was a small matter to collect and store students' output to the assessment tasks. Several related questions were posed. Were the tasks clearly defined and limited to the time and environment? Were human factors addressed in the presentation of material and equality of access for all groups including management of technology?

Practical work in Engineering Studies and AIT had similarities but were largely different. For Engineering the work output is generally bulky and conducted in large workshops. The AIT

lessons and projects are generally conducted in computer labs. Observations and interviews were the sources of data used to construct a picture of attitudes and perceptions about this manageability dimension. From the data analysed, the researcher deduced the feasibility of manageability associated with the realities of implementation of digital forms of assessment in a typical or normal classroom in schools.

Functional dimension

The functional dimension concerned how well the assessment tasks function as a measure of student achievement or capacity. This is usually described as the reliability and validity of the assessment. The study only considered student and teacher perceptions of validity and reliability against the backdrop of student achievement or capacity. The larger overarching study also calculated statistical measures of reliability and validity. From the teacher interviews and student forum data the researcher collected evidence to address the feasibility of this dimension.

Technical dimension

This dimension concerned whether the technology applied operated effectively. Both the schools and externally provided technologies were investigated in terms of scope and appropriateness for assessment purposes. Several questions were posed. To what extent did the schools' technologies need extension to comply with assessment requirements? Was the e-Scape tool relatively easy for students compiling their portfolios and the researcher to manage timing and sequencing of activities? Data collected from student survey and forums, together with the researcher's visits to schools and initial teacher interview data were used in addressing this dimension.

Pedagogic dimension

This dimension concerned whether the assessment task was consistent with the intended, preferred and actual pedagogies. For Engineering Studies this was likely to be different to AIT, as the learning environment differs between workshop and computer lab. Mostly students' and teachers' conception of efficacy towards digital forms of assessment provided clarification of pedagogies and classroom culture in addressing this dimension.

Concerns-Based Adoption Model

The results of the analyses of the range of data were also interpreted employing the CBAM. Each of the three diagnostic dimensions of the model, the IC, SoC, and LoU, required the researcher to be immersed in an innovation scene of the innovation, continually refining judgements associated with the diagnostic dimensions. The innovation was the digital form of assessment implemented in the class. Teachers' responses to the structured interview protocol were analysed following the constructs, SoC six and LoU eight levels. One of each of the levels within each construct was determined for each response (see Appendices A, B and C).

An Innovation Configuration (IC) was used to define the innovation and its implementation (Patton, 1990). A two-dimensional checklist was constructed to represent the IC. This consisted of the major features of the innovation, known as components, listed vertically with the different ways in which each component was operationalised, known as variations, listed horizontally. The documents associated with the assessment tasks for the two courses were used to develop the IC using the guidelines developed by the CBAM project team (Hall & Hord, 1987). Initial attempts at developing the IC checklist were validated by two curriculum experts who were also consultants to the main project. The IC were used not only to define the innovation, but also assisted in describing the implementation of the innovation by the teachers for whom case studies were developed. Using all the data related to the teacher and class, the researcher employed the variation for each component of the IC, which best described the extent the innovation had been implemented. The IC for this study is provided in Appendix A.

The Stages of Concern (SoC) was used as a framework analyse some of the questionnaire data. This framework included a set of stages providing a numerical and descriptive picture of the type and strength of participants' concerns about the innovation (Heck et al., 1975). This was utilised to assist in constructing the first teacher interview questions. This framework is provided in Appendix B.

The Level of Use (LoU) was used to describe 'what a teacher is doing or not doing in relation to the innovation' (Hall & Hord, 1987). They implemented an LoU interview process with an interview guide supplemented by observations which placed participants in hierarchical levels CBAM provided a LoU interview rating sheet which had a two dimensional grid with the eight levels forming the rows, and seven categories of LoU forming the columns. They provided a general description of behaviour for each cell likely to indicate the appropriateness

the level which should be applied to that dimension. Interview transcripts were also used for the allocation of each dimension and an overall level allocated. This framework is provided in Appendix C.

Role of Researcher/Observer

This research was ethnographic in nature employing interpretive methodologies which required the researcher to become a part of the learning environment in order to collect relevant data.The researcher was an experienced Head of Learning Area for Technology and Enterprise, with many years of teaching and curriculum implementation experience, including in the Engineering Studies and AIT courses. He was also part of the research team for the overarching study, participating as a teacher in the AIT component of the study in its first year. The involvement in the earlier stage of research had provided the researcher with valuable knowledge and understanding of interpretive methodologies; this assisted in collecting data. In addition the main analysis tool in this study was CBAM, requiring immersion in the learning environment of the innovation and refined judgements associated with the dimensions of the model. Classes were observed, teachers interviewed and channels of communication with them opened before and after the exams, and students interviewed. During these periods of observation, hand written notes were kept, and records of what students were doing with ICT devices in class activities. On occasions instructional task instructions were for students, and conversations relating to clarification of computer use were given, and any technical issues related to their workstations rectified.

This personal level of involvement also provided the researcher with clearer and richer insights into students learning activity and their thoughts about completion of their tasks or assessment, when the lessons conducted during visits to schools were observed. This research related activity provided personal opportunity to develop relationships engagement with students and teachers, thereby ensuring the collection of highest quality of data throughout the collection cycle.

However by becoming part of the environment could be perceived as the researcher influencing the environment. In the study this was highly unlikely because this study was part of the larger research conducted by ECU, all ethical requirements being binding thus applying to this study. The researcher was also party to the larger research and understood interpretive methodologies, which in part was to follow protocol and apply triangulation as part of the

results. In this research the presence of the researcher was mainly to ensure the interpretation and collection of high quality data. By adhering to protocol and ensuring the process of collecting data was similar for all case studies, the researcher over-viewed the validation of results from all sources, classifying and cross-checking ensured and avoided bias across this study.

Ethical Considerations

All responses to questionnaires and content analysis of curriculum instructions used by schools were treated strictly confidentially. Anonymity was assured in all reports and publications of the study. As this study was part of a larger research conducted by Edith Cowan University all ethical requirements and protocols was binding with the parent research study. Upon completion of this study a copy of the thesis was submitted to the schools on request and a copy was available to Edith Cowan University.

Summary

This chapter has described the research methods, samples, data sources and methods used to obtain data on the perceptions and attitudes of teachers and students towards the use of ICT, and the feasibility of using digital forms of student work output on authentic summative performance assessments for the Engineering Studies and AIT courses.

The next three chapters will present an analysis of the data collected. In Chapter 4 the student survey data is analysed for all samples taken for Engineering Studies and AIT. Chapters, 5 and 6 discuss case-by-case study for two subjects being investigated. Finally Chapter 7 summaries the findings. Chapter 8's discussion will conclude the thesis.

CHAPTER FOUR: RESULTS OF ANALYSIS OF SURVEY OF STUDENTS

This chapter reports the results of the analysis of the complete student survey data for Engineering Studies and AIT collected at the ten schools involved. The interpretation of results will provide some insight into students' attitudes and perceptions about the use and value of ICT in supporting assessment for the two courses. The results also provide a backdrop for the case studies in the next two chapters.

Student surveys were conducted with all classes involved in the study using a student questionnaire customised for each course (see Appendix F). An inductive reasoning approach was applied to the data analysis and while specific questions were posed to guide the study, no hypotheses were formed prior to analysis of the data collected. The data used in this study were mainly qualitative, due to the its nature and scope. However, for the student survey data, some quantitative analysis was conducted prior to isolation of themes and trends forming students' attitudes and perceptions. These analyses are presented in this chapter.

For the Engineering Studies course, five schools, six teachers and seven classes of students were involved. These classes spanned the three engineering the specialisation areas, namely mechanical, electrical and control. The students completed a three-hour design project having a computer-based exam as part of the study.

For the AIT course five schools, five teachers and five classes of students were involved. Students in these classes completed a digital reflective-process portfolio and a computer-based exam. These AIT classes focused on the 2A-2B Business Information Technology context of the Stage Two AIT course.

This chapter firstly reports on the analysis of the survey of Engineering Studies students, then the AIT students, and finally summarises and compares results from both samples.

Engineering studies student survey

The Engineering Studies student questionnaire consisted of 58 closed response items and two open response items. It was administered at the completion of the computer-based exam. The questionnaire was employed to collect data from students about their attitudes and perceptions towards the employment of ICT in assessments, and ICT use itself, including perceived level of ICT skills and experience, and their experience of the exam assessment task. Survey data

were collected from 84 students being entered into an Excel spreadsheet and SPSS. Descriptive statistics were generated for the closed-response items of the student survey and scales were constructed from groups of items. The Engineering student questionnaire is listed in Appendix F.

From the results of the analysis of the student survey, the following will be discussed: responses to the two open-ended questions (E3 and E4) which were concerned with the Engineering exam; responses to the 58 closed-response items; and the six descriptive scales, namely: eAssess, Apply, Attitude, Confidence, Skills and SCUse, created from sets of closed-response items. The conclusion will draw out construct themes describing student attitudes and perceptions towards the use of ICT to support the assessment they experienced.

Open response items from the survey

Two open-ended items (Appendix F, E3 and E4) asked students to list the two best things and two worst things about composing the design project Engineering examination using computers. A variety of responses to these items were tabulated to assist in drawing out themes. Further analysis of these data will occur as a part of the case studies in the next two chapters.

For the two best things a sample of most students' responses was centred on: 'I can show my best work', 'It was easier and faster to type than to write','It was quicker and easier to correct mistakes', and 'It was relevant to the real world that Engineers use computers for design'. Overall, students indicated they appreciated performing an assessment task with ICT support and considered employing computers for the assessment matched the pedagogy required of the Engineering course. Most students indicated they preferred typing on a computer to writing in the exam because it was more efficient, quicker, neater and provided more clarity in their work. They found the exam challenging but fun to complete on computers.

For the two worst things, most students' responses were centred on concerns with technical malfunctions, 'Such as computers too slow', 'Needing to re-boot computers during the exam', 'Need time to get used to and more familiar with hardware functions, EeePC computer screen and keyboard too small', and 'Using the webcams'. However, the technical problems students highlighted were all adequately addressed at the point of need during the exam. In some cases where technical issues with hardware were not resolved quickly, students were moved to

another location where they could continue with the exam. This caused a short delay and students were given extra time for the exam.

Closed response items from the Survey

Each of the closed response items was analysed separately, before considering the results for combining items to form scales. Refer to Appendix U.

E1 items

The two items (E1a and E1b) asked the frequency of completing a design project on a computer, and the time required for competence in doing so. These items were coded with 1 for 'Lots', 2 for 'Some', 3 for 'Little' and 4 for 'None'.

The E1a item, which concerned the frequency of completing a design project on a computer previously, had a mean of 2.44 and SD of 1.0 indicating more responses (61%) were around 'Some' and 'Little'; 21% of responses were for 'Lots', and 19% for 'None'. Approximately 82% of the sample indicated having cmpleted at least some design project work on computers previously. However, in general this research cohort had only limited experience of completing a design ptoject using a computer.

The E1b item was concerned with the required time for the student to feel confident in completing design projects on computers. It had a mean score of 2.7 with an SD of 0.8, with 46% responses given as 'Little', 31% 'Some' and 7% 'None'. In general, most students perceived needing more time when faced with design project work on computers. However, a small number of students (7%) had a strongly positive perceptions of not requiring more time in becoming confident with computer use. This indicated they had a highly positive attitude towards the value of the role of ICT in design project work in the course.

E2 items

Broadly E2 was structured to complement E1in seeking students' perceptions of their experience in performing a design project for an exam. Responses from E2 provided some understanding of students' attitudes and perceptions about the use of computers to support this form of assessment.

The 11 items in question E2 (a – k) were concerned with the efficacy of the exam and the use of computers to support undertaking it, that is, they were easy to use, easy to develop design ideas, a quick way for recording and presenting ideas, good tools for modelling and compiling

a portfolio, and better than doing the design on paper. The items were coded: 1 for 'Strongly Agree', 2 'Agree', 3 'Disagree' and 4 'Strongly disagree'. Thus these items were reverse coded, that is, 1 becomes most positive, and 4 the least. Item means ranged from 1.64 to 2.01, with most means around 1.9, that is, mainly around the 'Agree' response. There was little spread between 'Disagree' and 'Strongly disagree' responses.

The E2a item concerned the ease of computer use for undertaking the design project exam had a mean of 1.85 and an SD of 0.6. There were 27% responses for 'Strongly agree', 62% 'Agreeing', 9% 'Disagree' and 1% 'Strongly Disagree'. Most responses tended towards 'Agree', with relative few disagreeing. In general, most students (89%) perceived they had relevant experience in undertaking Engineering design projects and had found using a computer made it easier. They inferred that they had a strongly positive attitude towards, and perception of, the use of ICT to support this form of assessment for the course.

The E2b item regarding the ease of using the computer for developing design ideas, had a mean of 2.01, which was relatively higher, i.e, less positive than the other E2 items, with an SD of 0.7. The responses tended towards 'Agree' with 20% of respondents opting for 'Strongly agree', 61% 'Agree', 17% 'Disagree' and 2% 'Strongly disagree'. The relatively large number who disagreed may indicate that developing and designing ideas with a computer probably needed further teaching, experience and support.

The E2c item, concerned with whether the use of the computer was a quick way for recording design ideas had a mean of 1.81 and an SD of 0.8. The 'Strongly agree' responses comprised 42%, 38% 'Agree', 17% 'Disagree' and 2% 'Strongly disagree'. The mean was close to the 'Agree' response and a relatively good spread was observed between the 'Strongly agree' and 'agree' responses; this indicated the majority of these responses reflected the perception that the computer was a quick way for recording their design ideas. As for the previous item only 19% disagreed. This was probably because they had limited experience with computer-based use as reflected in item E1.

The E2d item interested in whether the computer was good for recording their design and modelling, had a mean of 1.87 and an SD of 0.7. The 'Strongly agree and agree had 81% of the responses, while 20% disagreed, indicating a relatively strong positive perception of this use of computers in the assessments.

The E2e item measuring whether the computer had potential for evaluating design ideas had a mean of 1.9 and SD of 0.7; 53% responses 'Agree', 29% 'Strongly agree', 14% 'Disagreeing'

and the Strongly disagree option was not represented. These responses represented a relatively strong positive perception of the role of the computer in the exam.

The E2f item concerning whether the computer was an aid in the compilation of portfolios had a mean was 1.64 and SD of 0.7. Approximately 90% of responses were recorded for 'Strongly agree' and "Agreeing'. These responses were relatively more positive for this item, compared with the other E2 items, indicating students were highly familiar and experienced with digital portfolios; most of their compilation of ideas with computers is achieved during their course work. They had reflected this positive attitude in the student forum also.

The E2g item, concerned following the steps of the design on the computer, had a mean of 1.65 and SD of 0.7, with 92% of responses to the 'Strongly agree' and 'Agreeing' items. This represents a strongly positive perception of computer use for design processes. They indicated they could make corrections easier and quicker than on the paper-based format and illustrate their best ideas using a computer.

The E2h item which measured steps of the exam helped in developing design ideas had a mean of 1.95 and SD of 0.7; 56% responses were recorded for 'Agree' and 25% for 'Strongly agree'. The response mean approximated the 'Agree' response. Overall this cohort displayed a strong positive perception towards the nature and structure of the assessment.

The E2i seeking responses to the item cncerning whether the computer was a good tool for designing and modelling had a mean of 1.81 and SD of 0.7; with 85% of responses being for 'Strongly agree' and 'Agree'. Most students were strongly positive in their perception that the computer was a better tool than the pen for designing their projects.

The E2j item concerned whether the design project allowed them to reveal their computer talents had a mean of 1.88 and SD of 0.7; with 83% of responses spread between 'Strongly agree' and 'Agree'. A relatively higher percentage (50%) of responses were for 'Agree'. Overall this group strongly perceived computer use to help them; they were able to demonstrate their capabilities in the exam. This mirrors the previous item (E2g) showing strongly positive attitudes to the use of ICT in supporting assessments.

The E2k item was interested in whether the computer was better than paper completing the project had a mean of 1.83 and SD of 0.9; responses for 'Strongly agree' were 43% and 36% for 'Agree'. This indicated a strong positive perception of a computer-based assessment rather than the traditional pen and paper approach indicating students' attitudes and perceptions

were strongly positive towards a computer-based pedagogical environment for the Engineering Studies course.

Q5 items: Hardware and Internet access

The eight items in Q5 concerning the devices available to them at home included: computer, digital camera, video camera, mp3 player or iPod, laptop computer, and game console. The codes applicable were: 0 for 'did not use' and 1 for 'use'.The 83 responses to Q5a revealed the following computer usage: 78% 'computer', 78% 'digital cameras', 50% 'video cameras', 93% 'mp3 players', 82% 'laptop' computers, 84% 'game consoles', 88% 'mobile phones' and 49% 'webcams'. On average, 74% of students used one or more of the devices listed, the mp3 player being the one device almost all students used. This was the norm for all students across the schools. Only 7% responses indicated a '0' code. The most common three devices used were laptop, game console and mobile phone. The web cam was the least used device.

Q6 concerned the type of Internet access available at home. One of three choices could be selected: 'No Internet', 'Dial-up Internet' and 'Broadband Internet, coded respectively 1, 2 and 3. Most responses (95%) indicated access to Broadband Internet, 4% Dial-up Internet and 1% no Internet access. The vast majority of students had access to Broadband Internet and could access to up-to-date on-line ICT to support learning and social networking and information. This response rate points to the development of positive attitudes and perceptions towards the 'Digital' environment in the future.

Q7 concerned the frequency of computer usage at home, with one of four choices to be selected from: 1 being 'Most days', 2 'More than once a week', 3 'Most weeks' and 4 'Rarely'. There were 79% responses indicating 'Most days', 17% 'more than once a week', 2% 'Most weeks' and 1% 'Rarely'. Clearly almost all students regularly used a computer at home.

Q8 measured the amount of student computer usage time in minutes spent using computers at school on each day during the last week. There were 84 responses with significant variability within zero to 240 minutes per day, based on a maximun possible of 360 minutes using computers at school. Most responses indicated that on average more time was spent (63 mins) on Fridays, and the least (48 mins) on Tuesdays. Generally on average 58 minutes per day was spent using computers at school in the previous week.

Q9 related to the use of all fingers when touch-typing. Of the 78 responses, 60% touch-typed using all their fingers and 40% did not. They had also indicated in Q3, open-end response, they could type faster than write in the Engineering studies exam. This personal facility may have helped them in the exam.

Q10 items: Using a computer for particular activities

Q10 comprised 6 items (a-f), concerned with computer use for particular activities such as, listing addresses of friends, drawing a diagram or picture, typing an assignment for school, doing line or pie graphs, sending a letter to club members or groups of friends, and communicating via MySpace, Facebook and YouTube. The codes were 1 (I do), 2 (I would) and 3 (No). Eighty four responses were received for all the items with the exception of Q10a (83).

The Q10a item concerned listing addresses of friends in which 51% of responses were fairly spread between 1 and 2, indicating respondents either kept a list or would keep a list of addresses of friends, the remaining 49% of students would not. This result could be attributed to the use of mobile phones and text messages, most students having access to these devices.

The Q10b item related to drawing a diagram or picture with 51% of responses being well spread between the 'dos' and 'do nots'; however a large number of students who did not find the need or the convenience of drawing with a mouse, for using the computer for diagrams or drawing pictures in their course.

The Q10c item provided evidence about computer use when typing an assignment, Of the reespondents, 94% typed their assignments. Only 1 student out of 84 indicated otherwise.

The Q10d item required an answer regarding compsing a line or pie graph. There were 64% of responses indicating part of an assignment. Probably these students were comfortable with using a spreadsheet when needed.

The Q10e item concerned sending a letter to which 84% of responses indicating use of a computer for emailing groups. However a relatively large number of students (16%) gave a negative, perhaps finding other means of 'text-based' communication like SMS. Perhaps the latter students had attitudes towards emailing which were similar to respondents of item Q10a.

The Q10f item, was about communication using social networking sites. There were 86% responses indicating that they do, and 11% would and a small percentage (4%) indicated a 'No' response. Most students were familiar and confident with the social media environment.

Q11 items: Computers at school

Five items comprised Q11, namely a-e, these items being structured to elicit the 84 respondent students' attitudes and perceptions towards the value of using a computer at school and at home. Codes were 1 'Yes', 2 'Sometimes' and 3 'No'.

Q11a concerned whether using computers at school makes work more difficult. The item was a reverse item with 3 'No' being the most positive and 1 'Yes' the least. The mean was 2.61 and SD of 0.6, 7% responses indicating 'Yes', 25% "Sometimes", and 66% 'No', The latter represented a high level of acceptance in agreeing that computer use at school did not make studying more difficult. This indicated positive attitudes and perceptions towards using computers at school.

The Q11b item related to the enjoyment of using computers at school, scoring a mean of 1.35 and an SD of 0.6, there were 74% responses indicated 'Yes', 18% 'Sometimes', and 8% 'No'. These responses indicated a positive attitude towards computers.

The Q11c item concerned liking to use computers for schoolwork. A mean of 1.26 and SD of 0.5 was recorded. Most students (64%) indicated they liked using a computer at home to do their schoolwork. These responses were relatively similar their attitudes they had for using computers for school work which were strongly positive.

The Q11d item concerned liking to discover matters instead of being told. This item had a mean of 1.61 and SD of 0.6. Some students (32%) were happy to find things out for themselves, but the majority did not feel as confident. They indicated they might sometimes to find things out for themselves.

The Q11e item asked whether computers are good for the world; it had a mean response of 1.25 and SD of 0.5. The majority of students (62%) indicated that computers were good for the world. These responses demonstrated a positive attitude towards the role of computers in general.

Q12 items: Students' confidence in working with computers

There were 6 items in Q12, a-f structured to elicit students' confidence in using and working with computers. Codes were: 1 'Yes', 2 'Not Sure' and 3 'No' leading to 84 responses to the items. The mean for Q12 items tended towards 2.0, all item being between 1.11 and 2.79.

Item Q12a item concerned confidence in working with computers comprising 93% responses indicating 'Yes', with approximately 7% shared between 'Not sure' and 'No'. Thus a mean of 1.11 and SD of 0.4 indicated a very positive response.

Item Q12b asked whether individuals of the responding cohort were good at using computers. A response level of 84% indicated 'Yes', 14% 'Not sure', and 1% 'No. The mean was 1.17 and an SD of 0.4 represented a high level of confidence.

Item Q12c concerned trying a new problem on the computer. An 82% of responses indicated 'Yes', 15%,'Not sure', and 2% 'No'. a mean of 1.20 and SD of 0.5. The responses told of most students having a high level of confidence when trying a new, computer-based problem. Item Q12d asked the students if they usually did well with computers; 89% of responses indicated 'Yes', 8% 'Not Sure' and 1% 'No'. The mean of 1.12 and SD of 0.4 showed a large number of students were positive, believing they usually did well when employing computers.

Item Q12e asked whether the students had the confidence to learn programming a computer. There were 52% responses indicating 'Yes', 33% 'Not Sure' and 14% 'No' with a mean of 1.62 and SD of 0.7. Slightly over 50% of students were confident they could learn to program a computer. The remainder were mostly not sure learning to program. This was the lowest level of confidence for these items, but it concerned the most difficult task.

Item Q12f asked whether using a computer was difficult for the responding cohort. There were 87% responses indicating 'No', 5% 'Not Sure' and 8% 'Yes'. The mean was 2.79 and SD of 0.6; revealed most students to be confident in using a computer and did not believe it to be difficult to use them.

Q13 items: Student's skills

Eleven items comprised Q13a-k, these were structured to elicit students' self-assessment of skills in using the types of computer software listed: Word processor, Spreadsheets, Databases, Slideshow software, Email, Computer File Management, Internet, Web page authoring, Digital photography, Image editing, and Video editing. The codes ranged from 1 'I can't do much' through 2, 3 and 4 indicating progressively more they could undertake with

levels such as '2' being introductory, '3' competent and '4' high skills; yielded 83 responses in total. The means ranged between 2.47 (Databases) to 3.72 (Internet).

The Q13a item asked students about using the word processors; it had a mean of 3.6 and SD of 0.5. There were 61% responses indicating they were competent and could use columns and sections, and styles with word processing, 4% indicated that in addition they were also competent with mail merge skills. Only one student responded by indicating little or no skills.

Item Q13b sought responses about using spreadsheets; it had a mean of 3.1 and SD of 0.7. There were 26% responses indicating the use of complex formulae, absolute and relative cell references, approximately 60% and 4% did not have enough confidence. Most students perceived they had relatively good skills using spreadsheets.

Q13c concerned using databases; it had a mean of 2.5 and SD of 1.04. Responses indicated most students were less skilled using databases than all other applications. The responses were well spread between 24% ('can't do much'), 22% (could create data files, enter data, and use simple queries to retrieve data), 37% (could create simple tables, use wizard to create reports and forms), and 17% (could create a relational database). Most students perceived they had relatively less skills using databases. Most likely they did not need much database application in their course work.

Item Q13d, using slideshows, had a mean of 3.6 and SD of 0.6. The 83 responses indicated most students (64%) could create a master slide, include sound, print handouts, and add navigation buttons, 30% could navigate during a presentation, add animations and transitions and insert hyperlinks, and 6% had lesser skills. Most students perceived they had relatively good skills using slideshows.

Q13e, using Email, had a mean of 3.7, one of the highest means for these items, and an SD of 0.6. The 70% of responses were at the highest level, pointing out the respondents could add a signature and attachments. However, a small number (7%) were not very competent with this task. Most students perceived they had relatively good skills using email.

Item13f, using Computer file management, had a mean of 3.55 and SD of 0.7. The response rate of 66% responses indicated the students could zip and unzip files, and install software. The remaining 23% could at least recognise different file types, navigate between drives and directories and use the Help file. Most students perceived themselves as having relatively good skills in computer file management.

Item Q13g, using The Internet, had a mean of 3.72 and SD of 0.5. The highest level garnered 76% response rate indicating the students could conduct complex searches, download and install plugins, use different browsers, and alter browser preferences. Another 18% could at least save images and text, use advanced search tools, and organise Favourites; and 99% could navigate to known web sites, create Favourites and complete basic searches. This item was ranked highly by students, most perceiving they had relatively good skills using the Internet; they obtained most research by social networking on-line.

Q13h concerned using Webpage authoring; it had a mean of 2.64 and an SD of 1.1. The responses were well spread between the codes, 1, 2, 3 and 4. Slightly more than 50% indicated progressively more, and 20% less competence. However, a relatively large number of students (20%) evidenced the need for extra support to enhance their Webpage authoring skills. In general, most students perceived having sufficient skills in setting up a webpage.

Item Q13i, using Digital photography, had a mean of 3.52 and SD of 0.8, Most responses (64%) were around 4 indicating respondents could undertake more complex task in Digital photography. Around 35% were generally capable of taking photos with a camera or video and transferring images to a computer. Most students perceived they had relatively good skills using Digital Photography.

The Q13j item concerned Image editing; it had a mean of 3.34 and SD of 0.8. Most responses were spread between the 3 and 4 levels, leaning towards being able to undertake complex image manipulation using filters and other special effects. A small number (2%) revealed a low level of competence. Most responses (98%) were spread between 2 'capable of doing simple editing such as cropping, deleting and drawing', 3 'changing format sizes. and 4 'complex image manipulation using filters and other special effects'. Most students perceived they had relatively good skills using image editing.

The Q13k item was about capability in the use of video editing; it had a mean of 2.8 and an SD of 1.0. Most responses were well spread across 2, 3 and 4 with 10% indicating relative incompetence most students showed they were capable with the basics of using video editing software, while 27 % believed they could use advanced software to apply complex editing and special effects in video editing. Most students perceived they had relatively good skills in video editing.

Scales from the survey - Engineering students

Six descriptive scales were constructed from sets of the closed items: eAssess, Apply, Attitude, Confidence, Skills and SCUse (see Table 3.3). For each scale the score was calculated by averaging across the items. Some item codes were reversed so that, for all scales, higher scores were positive. For each scale except the SCUse scale, a Cronbach's Alpha reliability coefficient was calculated. The SCUse scale, was an average of the 5 quantities of times listed Monday to Friday; it did not have a reliability calculation.

The eAssess scale measured student perceptions of the efficacy of the Engineering exam and the use of computers to support it, by combining all the items in Q2a-k. The Apply scale measured the application of computer uses by combining all the items in Q10a-f. The Attitude scale measured student attitudes towards computer use by combining all the items in Q11a-e. The Confidence scale described confidence in using computers by combining all the items in Q12a-f. The Skills scale described a measure of self-assessing ICT skills by combining all the items in Q13a-k. The SCUse scale estimated the amount of time per day using computers at school by combining all the items in Q8 (Monday to Friday).

Descriptive statistics for the six scales are shown in Table 3.1 and the graphs in Figure 4.1 depict the distribution of scores. The reliabilities for the scales varied from a Cronbach's Alpha reliability coefficient of 0.5 to 0.9. The eAssess and Skills scales had high reliability coefficients with the other three scales lower and therefore not sufficiently reliable. The SCUse scale was a simple average of the five quantities of times listed and did not have a reliability calculation.

Table 4.1
Descriptive statistics for the scales developed from the Engineering questionnaire

Scale	N	α	Min	Max	Mean	SD
eAssess	84	0.9	2.00	4.00	3.2	0.5
Apply	84	0.5	1.67	3.00	2.4	0.4
Attitude	84	0.5	1.40	3.00	2.6	0.3
Confidence	84	0.6	1.67	3.00	3.0	0.3
Skills	83	0.8	2.09	4.00	3.3	0.5
SCUse	84	-	0	240	58	50
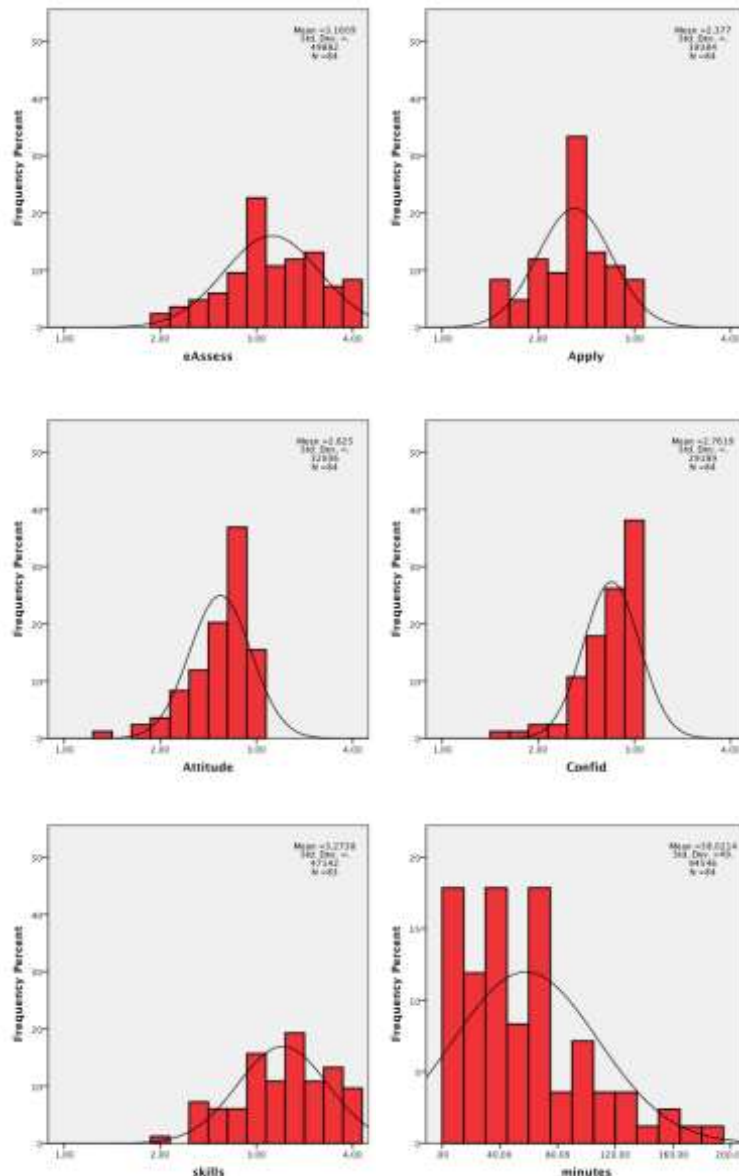
Figure 4.1 Distribution of scores on scales from Engineering Students questionnaire

eAssess scale

The eAssess scale was developed from the eleven E2 items of the student questionnaire concerning the efficacy of the Engineering exam and the use of computers to support it. Scores were possible between 1 and 4. A total of 84 scores were analysed on this scale. Most scores (93%) were above the midpoint of 2.5, indicating a strong positive perception. The mean was 3.2 and SD of 0.5, with a reliability coefficient alpha of 0.9, indicating 90% of internal consistency in the eAssess scale. Most students were positive about the Engineering design project and generally perceived using computers helped in completing the exam.

135

Apply scale

The Apply scale was developed from six items that comprised the student questionnaire Q10 related to the application of computers. Scores were possible between 1 and 3. A total of 84 scores was analysed on this scale. The mean was 2.4 and SD of 0.4, with a reliability coefficient alpha of 0.6, indicating moderate consistency in the Apply scale. A good distribution of students was apparent across the range 1.7 and 3.0. A large number of students scored between 2.33 and 2.50. Questions 10a and 10b, which asked whether they would 'keep a list of addresses of friends' and 'draw a diagram or picture' using a computer, which were the only two with relatively smaller means. The means for the remaining four questions, concerning whether students used a computer for recording, evaluating and compiling the design project (10c, d, e and f), were between 1.07 and 1.58, indicating students were comparatively less positive about these applications. However, they found using the computer was a good and quick way to record their design and modelling ideas from the open-ended questions.

Attitude scale

The Attitude scale was developed from five items from Q11 of the student questionnaire, which sought information about students' attitudes and perceptions towards using computers. Scores were possible between 1 and 3. A total of 84 scores were analysed on the scale. The mean was 2.6 and SD 0.3, with a reliability coefficient alpha of 0.5, was low and less reliable. Most students scored between 2.5 and 2.8, with a larger number averaging 2.8 which points to being generally positive.

Confidence scale

This scale concerned confidence in using computers. A total of 84 scores was analysed on this scale. The mean was 2.8 and a SD of 0.3, with a reliability coefficient alpha of 0.6, which a less reliable score when drawing conclusions with a degree of confidence. Most students scored between 2.5 and 3.0 so the inference could tend towards a perception of confidence in using computers.

Skills scale

This scale concerned about students' self-assessment of ICT skills. A total of 83 scores was analysed on this scale. The mean was 3.3 and SD of 0.5, with a reliability coefficient alpha of

0.8, indicating high degree of internal consistency in this scale. The mean was well above the midpoint of 2.5, indicating a strongly positive inference possible about their ICT skills.

SCUse scale

This scale estimated the time students spent per day using computers at school. A total of 84 responses was analysed on this scale. The mean was 58 minutes a day and SD of 0.5. A large range from no time to 240 minutes per day was evident; most responses were between 0 and 70 minutes a day, a little less than for the AIT students. It was not appropriate to calculate based on these scores so they were averaged and not aggregated.

Conclusions from responses of Engineering students

The Engineering exam was for students to complete a design project on a computer in the school's computer lab. The design tasks were broken into a number of timed activities, students being paced through each activity, recording their input in a form of digital portfolio online. From an analysis of the Engineering sample student survey results,the researcher drew conclusions about participants' attitudes and perceptions about the exam, and finally in general about the use of ICT for learning and assessment.

In general, most students appreciated the manner and the approach in which the Engineering exam was conducted as indicated by the high eAssess scores. They perceived the use of computers supported the assessment and believed it was an appropriate assessment tool. They felt confident completing the exam tasks with a computer.

Most students believed that compared with a conventional exam, it was easier to see what was being asked and talked about including pictures and graphical representation/s which helped them to express what they were thinking. They liked the exam tasks because it was easier to correct mistakes and neater; they preferred to type rather than to write. Their preference was for this method of exam over the traditional pen and paper format because it could be more creative, because they had access to ICT on a daily basis each day at school and at home. They also felt that using webcam and video recording were excellent ways of reflecting on their work. All of the students felt it was easier to use the computer to complete the design project; and that the computer was a good tool for design and modelling.

Most students were familiar with using computers for design work and were confident with the software. They felt their ICT skills enhanced their learning as indicated in the relatively

high Skills scale mean. ICT was well-used at school and at home; students were savvy with devices like iPhones, iPads, and tablets, demonstrating positive attitudes and perceptions towards ICT and learning.

AIT student survey

This questionnaire was similar to that for Engineering Studies but consisted of 66 closed-response items and four open response items. It was administered at the completion of the AIT exam. The questionnaire was employed to collect data from students about their attitudes and perceptions about ICT use in assessments, and the ICT facility generally, including perceived level of ICT skills and experience, experience of the assessment task. Survey data were collected from 94 students then were entered into a spreadsheet and SPSS. Descriptive statistics and Cronbach's Alpha reliability coefficients were generated for the items of the student survey and scales constructed groups of items. The AIT student questionnaire is listed in Appendix U.

From the results of the analysis of the student survey, the following will be discussed: responses to the four open-ended questions, E3 and E4 which concerned entering upon the AIT exam, and P1 and P2 which asked questions about composing the AIT digital portfolio; responses to the 66 closed-response items; and opinions regarding the seven descriptive scales, eAssess, eAssessP, Apply, Attitude, Confidence, Skills and SCUse, created from sets of closed-response items. The conclusion will draw out themes concerning student's attitudes and perceptions about the use of ICT to support the assessment they completed.

Open response items from the survey

Four open-response items similar to that for Engineering Studies related to the exam were evaluate along with an additional two for the portfolio. Responses to the these items were tabulated to assist in drawing out themes. The responses were varied. Further analysis of these data will occur in the case studies in the next two chapters. Refer to Appendices L and M for open item responses to the best and worst scenarios of the Engineering exam.

AIT Exam open response items

Two open-ended items, E3 and E4, asked students to list the two best and two worst things about completing the AIT examination using computers.

The items concerning the two best matters, E3a and E3b, were constructed to give students the opportunity to express more fully their attitudes and perceptions towards accepting the value of doing the exam in the computer laboratory. Various responses were recorded but a sample of answers was centred around: 'Able to use technology in an Applied Technology exam'; 'Helped to show ideas more clearly'; 'More opportunities to be creative'; 'Able to show what I can do'; 'Easy to correct mistakes' 'Could type faster than write'; and 'More reflective of the curriculum'. The general conclusion was the students indicated a strongly positive perception of the computer-based exam.

The two worst things, E4a and E4b, gave students the opportunity to express more fully their attitudes and perceptions about the challenges and complexity experienced during the exam in a computer laboratory. Various responses were given, but most centred on hardware mal-functions; however, some respondents were concerned about unclear exam instructions, confusion with file formats, and setting up subfolders. These issues were addressed at the beginning of the exam and overall all students completed the exam in the time allocated. Generally most of their concerns were computer network related in nature, and were temporary. For the few who were concerned with exam instructions, the conclusion is they inexperienced in taking exams on a computer.

AIT Portfolio open response items

Two open response items, P3 and P4, that asked students to list the two best things and two worst things about doing the AIT digital portfolio.

The two best things about doing the AIT digital portfolio (P3a and P3b), provided students the opportunity to express more fully their attitudes and perceptions about the value of undertaking a digital portfolio. The two best things elicited various responses, a sample of most being centred around such comments as: 'I can show what I can do in a portfolio'; 'It was easy to setup and to put my work files into one portfolio'; 'It was easy to access all my files'; and ' Much more organised'. Generally, a similar conclusion could be made – the students indicated a strongly positive perception of a digital portfolio.

The two worst things were recorded from questions (P4a and P4b), which gave students the opportunity to express more fully their attitudes and perceptions about the challenges and complexity they experienced composing the digital portfolio. The various responses centred on: 'Took time to access files'; 'Having to setup your own portfolio'; and 'Files won't save

properly'. These issues were mainly for those students who needed additional support with using computers and, to some degree, the understanding of file management protocol. Generally the students indicated a frustration with hardware and software compatibility with file format conventions.

Closed response items from the survey

Each of the closed response items was analysed separately before considering the results of combining items to form scales. Refer to Appendix W for AIT student survey results.

E1 items: Doing exams in the computer laboratory

Two items, E1a and E1b, asking the frequency with which the students had completed an exam or test on a computer before, and how much more time they would need to get used to doing so. These items were coded with 1 for 'Lots', 2 for 'Some', 3 for 'Little' and 4 for 'None'.

The E1a item had a mean of 3.22 and SD of 0.8; with 1% of responses for 'Lots', 17% 'Some', 39% 'Little' and 40% 'None'. Generally 80% of responses centred on 'Little' and 'None'. The majority of students perceived they had little or no experience competing in exams on a computer.

The E1b item additional time needed for the AIT exam in a computer lab had a mean of 2.58 and a SD of 0.8. Most responses (77%) clustered around the 'Some' and 'Little' with 7% of responses for 'Lots' and 14% for 'None'. Clearly the vast majority of students perceived a lack of experience with computer-based exams, and would need some time to become proficient in them.

P1 items: Doing portfolios using computers

Two items, P1a and P1b, asked the frequency of completing a portfolio on a computer before, and how much more time would be needed to get used to doing so. These items were coded with 1 for 'Lots', 2 for 'Some', 3 for 'Little' and 4 for 'None'.

The P1a item had a mean of 2.47 and a SD of 1.2. Most responses (56%) clustered around 'Some' and 'Little' with 17% of responses for 'Lots' and 21% for 'None'. Therefore, approximately 73% of responses indicated the students had completed a portfolio on a computer previously.

140

The P1b item about the extra time necessary for completing a digital portfolio had a mean of 2.29 and SD of 1.1, 64% responses clustering around 'Some' and 'Little' with 12% of responses for 'Lots', and 16% for 'None'. Although most students indicated they had completed a portfolio on a computer previously, a relatively large number perceived they still needed extra time to become familiar completing a portfolio on a computer. They were generally confident with this type of digital portfolio.

E2 items: Doing the AIT exam

Broadly E2 was structured to complement E1 in seeking students' perceptions of their experience of doing the AIT exam. Responses from E2 provided some understanding of students' attitudes and perceptions towards the use of computers to support assessment.

Question E2a-k was comprised of concerned with the efficacy of the AIT exam and the use of computers to support it including: easy to use, easy to develop design ideas, a quick way for recording and presenting ideas, a good tool for modelling and compiling portfolio, and better than doing the design on paper. The items were coded 1 for 'Strongly Agree', 2 'Agree', 3 'Disagree' and 4 'Strongly disagree', thus these items had reverse coding, 1 the most positive and 4 the least. The means calculate ranged from 1.70 to 2.16; with most means between 2.01 and 2.16 clustered around the 'Agree' response.

 The E2a item had means of 2.01 and SD of 0.6; with 17% of responses being 'Strongly agree', 67% 'Agreeing', 14% 'Disagree' and 2% 'Strongly disagreeing'. Most responses leaned towards 'Agreeing', indicating the students had a positive perception of the ease of computer use in the exam.

The E2b item about the utility of computer for developing their design ideas had a mean of 2.16 and SD of 0.7. Most responses (60%) were 'Agree', 14 'Strongly agree', 23% 'Disagree' and 2% 'Strongly disagree'. The relatively large number of students who disagreed indicates that developing and designing ideas with a computer needed further experience and support.

The E2c item concerned the computer being a quick way presenting their design ideas in the exam had a mean of 1.94 and SD of 0.7. Most responses (56%) were 'Agree' while 25% were 'Strongly agree', 17% 'Disagree' and 1% 'Strongly disagree' they responses were strongly positive; the students belieiving the computer to be a quick means of presentation.

QE2d concerned the computer's usefulness in graphic displays and had a mean of 1.70 and SD of 0.7. Most responses (47%) were 'Agree', 41% 'Strongly agree', 10% 'Disagree' and

1% 'Strongly disagree'. Most students indicated a positive perception of the value of a computer-based exam.

The E2e item asked of the computer reflecting students' design ideas in the exam; it had a mean of 1.98 and SD of 0.6; with (63%) were 'Agree', 20% 'Strongly agree', 16% 'Disagree' and 1% 'Strongly disagree'. The respondents were strongly positive in their belief that computer's help in their reflection and design ideas during the exam.

QE2f asked of computer aid in answering exam questions; it had a mean of 2.0 and SD of 0.6. Most responses (64%) were 'Agree', 18% 'Strongly agree', 16% 'Disagree' and 2% 'Strongly disagree'. Students felt positive in general towards using the computer's use when answering exam questions.

The E2g item required answers about the ease of computer use; the mean was 2.0 with an SD of 0.7; Most responses (55%) were 'Agree', 21% 'Strongly agree', 21% 'Disagree' and 2% 'Strongly disagree'. Student responses were generally positive towards following exam instructions on the computer, although for 23% required further coaching and support.

Item E2h sought information about the computer assisting the development of their design ideas; it had a mean of 2.1 and SD of 0.7. Most responses (61%) were 'Agree', 17% 'Strongly agree', 18% 'Disagree' and 3% 'Strongly disagree'. The students were generally positive towards accepting the value of the steps given in the exam for developing their design ideas.

The E2i item inquired of the students' views on computers being a useful tool for the designing products in an exam; the responses had a mean of 1.8 and SD of 0.7. Almost half of the responses (53%) were 'Agree', 35% 'Strongly agree', 11% 'Disagree' with (1%) 'Strongly disagree'. The students were positive towards this computer application, indicating the computer to be a good tool for designing their exam outcomes.

QE2j asked of the computer's aid in their exam responses ; it had a mean of 2.1 and SD of 0.7. Most responses (58%) were 'Agree', (18%) 'Strongly agree', 'Disagree', 18% and (5%) 'Strongly disagree'. Students were positive, believing that the computer helped them demonstrate their talents in the exam.

The E2k item required an answer to whether a computer was better than paper; responses had a mean of 1.9; and SD of 0.8. Over one third of responses (39%) were 'Agree', 36% 'Strongly agree', 18% 'Disagree' and 3% 'Strongly disagree'. Although most responses (75%) were positive, a substantial group of students did not believe the computer was better than paper for

the exam. This could be because they were more familiar with paper exams. A similar perception was indicated in E1a, where a large group indicated they had not completed a computer-based exam or test previously.

P2 items: Doing the AIT portfolio

Broadly P2 items was structured to complement P1 items in seeking students' perceptions of their experience' in composing a digital portfolio, which included a product made in a project, a process document and two extra artefacts. Responses from P2 provided some understanding of students' attitudes and perceptions towards accomplishing the portfolio using computers.

Question P2 a-k comprised 11 items concerned with the efficacy and the ease of doing the AIT portfolio using computers, such as, whether the computer was easy to use, easy to develop design ideas, a quick way for recording and presenting ideas, a good tool for modelling and compiling portfolio, and was better than doing the design on paper. The items were coded 1 for 'Strongly Agree', 2 'Agree', 3 'Disagree' and 4 'Strongly disagree', thus requiring reverse coding, that is, 1 being most positive and 4 the least. Item means ranged from 1.70 to 2.50, with most means lying between 1.70 and 1.88, but essentially around the 'Agree' response.

The P2a item concerned ease of computer use; total responses had a mean of 1.90 and SD of 0.7; with 69% responses for 'Agree', 15% 'Strongly agree', 8% 'Agree' and 2% 'Strongly disagree'. Responses leaned towards 'Agreeing' indicating the students had a positive perception of the ease of the computer use in developing their ideas.

The P2b item required opinions ease of for developing their ideas; it had a mean of 2.0 and SD of 0.7; with most (67%) 'Agree', 13% 'Strongly agree', 13% 'Disagree' and 1% 'Strongly disagree'. The vast majority of students indicated they had a positive perception of the ease of computer use in developing their ideas for the digital portfolio.

The P2c item concerned speed of computer for presenting their ideas in the portfolio; it had a mean of 2.0 and SD of 0.7; with 'Agree' (64%), 20% 'Strongly agree', 10% 'Disagree' and no responses for 'Strongly disagree'. Therefore most students indicated a positive perception of the ease of computer use in presenting their ideas in the digital portfolio.

The P2d item concerned the computer's possibilities for creating their product for the portfolio; responses had a mean of 1.73 and SD of 0.8; with most (53%) 'Agree', 28%

'Strongly agree', 12% 'Disagree' and 1% 'Strongly disagree'. Most students indicated a positive perception to the use of the computer for creating the product for the digital portfolio.

The P2e item concerned computer utility for reflecting their ideas in their portfolio; it had a mean of 2.0 and SD of 0.8; with most (62%) 'Agree', 15% 'Strongly agree', 16% 'Disagree' and 1% 'Strongly disagree'. It represented a positive perception of the computer for reflecting their ideas for their process document using their portfolio.

The P2f item questioning whether the computer demonstrated their particular skills in the portfolio in the product and extra artefacts; it, had a mean of 2.0 and SD of 0.8. Most responses, (51%) 'Agree', 29% 'Strongly agree', 12% 'Disagree' and 2% 'Strongly disagree'. Generally most responses indicated a positive perception that it was good to use a computer to show their skills.

The P2g item queried the ease of following the steps to create the portfolio; it had a mean of 2.0 and SD of 0.8. Most responses (57%) were 'Agree', 19% 'Strongly agree', 16% 'Agree' and 1% Strongly disagree'. Most students indicated a positive perception of the value of following the steps on the computer in creating the digital portfolio.

The P2h item asked if the computer helped them to develop their ideas; it had a mean of 2.0 and SD of 0.8; with 60% 'Agree', 14% 'Strongly agree', 19% 'Disagree' and 2% Strongly disagree. Most students had a positive perception about the value of steps being easy to follow when creating the digital portfolio.

The P2i item concerning the computer's utility as a tool for creating portfolios had a mean of 1.70 and SD of 0.7. Overall of responses 62% 'Agree', 24% 'Strongly agree', 6% 'Disagree' and 1% Strongly disagree. Generally the students indicated a positive perception of the computer being a good tool for creating portfolios.

The P2j item asked about their portfolios; responses had a mean of 2.0 and SD of 0.8; with 61% responses being 'Agree', 22% 'Strongly agree', 8% 'Disagree' and 2% 'Strongly disagree'. Most students' responses indicated a positive perception of being able to demonstrate their skills in the portfolio.

The P2k item sought information better computer application in completing the portfolio; responses had a mean of 2.0 and SD of 0.8; with 49% 'Agree', 31% 'Strongly agree', 13% 'Disagree' and no responses for Strongly disagree. Most students indicated a positive perception in favour of the digital portfolio compared to pen and paper.

Q5 items were about experience and knowledge with computer technology. There were eight items concerning devices used at home: computer, digital camera, video camera, mp3 player, iPod, laptop computer, and game console. The codes were 0, 'did not use' and 1 for use. There were 71% having computers, 65% digital camera, 40% video camera, 77% mp3 player, 66% 'laptop' computer, 64% game console, 80% mobile phone and 48% webcam. On average almost all students used one or more of the devices listed. The mp3 player was one device that almost all students used. The most common four devices used were mp3 player, laptop, game console and mobile phone. The video camera and the web cam were the least used devices.

Q6 asked about the type of Internet access available at home there being three choices to select from, coded 1 = 'No Internet', 2 = 'Dial-up Internet' and 3 ='Broadband Internet. Most responses (81%) indicated access to Broadband Internet, 6% Dial-up Internet and 2% No Internet access.

Q7 concerned the frequency of computer usage at home; four choices to select from, 1 = 'Most days', 2 = 'More than once a week', 3 = 'Most weeks' and 4 = 'Rarely'. There were 72% responses indicating 'Most days', 8% 'more than once a week', 1% 'Most weeks' and 4% 'Rarely'. The vast majority of students with the exception of 'Rarely' regularly used a computer at home.

Q8 estimated the amount of time in minutes spent using computers at school on each day of the previous week. The 94 responses showed significant variability from zero to 180 minutes per day, based on a maximum allocation of 360 minutes per day at school. Most responses indicated that on average they spent more time (87 mins) on Fridays, and the least 75 mins on Mondays. Overall the average time spent of computer application at school during the previous week was 79 minutes per day.

Q9 asked about the use of all fingers when touch-typing, elicited 75 responses, of which 62% indicated they touch-typed using all their fingers and 16% did not. Most students indicated they could type faster than they could write.

Q10 items: Using a computer for a variety of tasks

There were 6 items in Q10a-f was comprised of 6 items concerned computer use for listing addresses of friends, drawing a diagram or picture, typing an assignment for school, doing line or pie graphs, sending a letter to club members or groups of friends and communicating

via MySpace, Facebook and YouTube. The codes used 1 = I do, 2 = I would and 3 =No. for between 83 and 85 responses.

Q10a, asked about typing the addresses of friends and, had a response mean of 2.20 and SD of 0.8; with 22% responses of 'I do', 28% 'I would' and 40% 'No'. They we well spread between 'I do' and 'I would', indicating the students were likely to keep a list of addresses of friends on their computers, the remainder would not.

For the Q10b item concerning drawing a diagram or picture, the mean was 1.90 and SD of 0.9, 40% of responses 'I do', 30% 'I would' and 30% 'No'. Somewhat more students were content with use of the computer for drawing a picture or a diagram. Possibly the small number of students who felt otherwise did not find the need, or the convenience.

The Q10c item concerned with typing an assignment had a mean of 1.11 and SD of 0.3, 80% of responses being for 'I do', 7% 'I would' and 1% 'No'. Clearly indicates more responses were strongly positive towards using the computer for typing assignments for school.

Q10d sought information about doing a line or pie graph; the number of responses had a mean of 1.50 and SD of 0.7, 58% being 'I do', 17% 'I would' and 13% 'No', thereby indicating a positive attitude towards using a spreadsheet. Most students had used a spreadsheet as part of their course assignment; therefore they were familiar with this computer application.

For the Q10e item concerned with sending a letter, the mean was 1.72 with an SD of 0.7. There were 37% responses of 'I do', 38 % 'I would' and 13% 'No'. The responses were mostly positive towards using email for communication, including group emails. However a relatively large number of students (13%) indicated in the negative; perhaps they used other means of communication, such as, social media, Facebook, Twitter, or Blogs).

The Q10f item seeking to know about communication using social networking sites had a mean of 2.0 and SD of 0.7, 75% responded 'I do', 8% 'I would' and 4% 'No', clearly indicating most students to employ social media or networking as a means of communication.

Q11 items: Attitudes and perceptions towards using a computer

There were 5 items in Q11a-e, structured to elicit students' attitudes and perceptions about the value of using a computer at school and at home. Codes utilised were: 1 'Yes', 2 'Sometimes' and 3 'No'. Q11a, was about whether using computers at school makes classwork more difficult. The item was a reverse item with 3 'No' being the most positive and 1 'Yes' the least. In this instance the mean was 2.80 and SD of 0.5, with 2% indicating 'Yes', 15%

"Sometimes' and 82% 'No'. A positive perception agreed that using the computer at school did not made work more difficult.

Item Q11b wanted a response about the enjoyment of employing computers at school. The mean was 1.30 and SD of 0.5 with 66% of respondents indicating 'Yes', 20% 'Sometimes', and '1% 'No'. The students overall had a strongly positive attitude towards using computers at school.

Item Q11c inquired of liking to employ computers at school; the mean was 1.40 and SD of 0.7, with 64% for 'Yes', 15% 'Sometimes' and 8% 'No. The students overall responded positively to the use of computer in homes accomplish their schoolwork.

Item Q11d the students' liking to find things out instead of being told. The mean of the responses was 1.71 and an SD of 0.6, with 32% for'Yes', 49% 'Sometimes' and 6% 'No'. Overall students felt they wanted to be told.

Item Q11e asked whether computers are good for the world? The mean of the responses was 1.33 and SD of 0.6; with 62% 'Yes', 22% 'Sometimes' and 3% 'No'. These student responses indicated a strongly positive attitude towards computers.

Q12 items: Confidence in using a computer

Q12a-f comprised 6 items structured to elicit students' confidence in using and working with computers. Codes were: 1 'Yes', 2 'Not Sure' and 3 'No' to 84 items. Completed items' means were between 1.09 and 2.68.

Item Q12a concerned confidence working with computers, the mean being 1.09 with SD of 0.3. Overall 80% of responses indicated 'Yes' and approximately 7% between 'Not sure' and 'No'. These student responses represented a very positive perception of confidence in using computers.

Item Q12b asked whether the student research cohort were competent at using computers; the response mean was 1.20 and SD of 0.4; with 71% responding 'Yes', 15% 'Not sure' and 1% 'No. These responses represented a high level of confidence.

Item Q12c inquired about trying a new problem on the computer, the mean of the responses being 1.23 and an SD of 0.5; with 71% 'Yes', 12% 'Not sure' and 4% 'No'. These responses represented a strong, high level of confidence.

Item Q12d asked if the student usually did well with the computer the mean of responses being 1.09 and an SD of 0.3; with a resulting 80% 'Yes', 7% indicating 'Not Sure' and 'No'. A large number of students' responses were positive, with the resulting perception they were usually felt competent on computers.

Item Q12e asked whether the student could learn to program a computer, the mean of responses being 1.44 with an SD of 0.6; with 55% 'Yes', 25% 'Not Sure' and 6% 'No'. More than 50% of students were confident they could learn to program a computer. The others were mostly not sure, or could not learn to program. This conclusion represented the lowest level of confidence for these items.

Item Q12f computer use being was difficult, the mean of responsed being 2.70 with an SD of 0.7. There were 12% indicating 'No', 4% 'Not Sure' and 71% 'Yes'. Most students were confident using a computer and did not believe it to be difficult.

Q13 items: Level of skills with computer hardware and software

There were 11 items in Q13 (a-k) comprised 11 items structured to elicit students' self-assessment of skills in employing the types of computer software listed, namely: Word processor, Spreadsheets, Databases, Slideshow software, Email, Computer File Management, Internet, Web page authoring, Digital photography, Image editing, and Video editing. The codes given showed 1 as 'I can't do much' through 2, 3 and 4 indicating progressively their levels with levels such as '2' being introductory, '3' competent and '4' high skills. Each of the 11 items received 75 responses. The means ranged between 2.71 (Databases) to 3.72 (Internet).

Item Q13a questioned the 75 students' competence in their deployment of word processors. The mean was 3.6 and SD of 0.7; with 61% of responses indicating a level between 'competent' and 'highly skilled'. They could use columns and sections, setup styles and use mail merge (coded 3 and 4). Only one student indicated relative incompetence (coded 1).

Item Q13b related to using spreadsheets resulting in a mean of 3.1 and an SD of 0.8. Of the responses 26% rated 'highly skilled' with complex formulae, absolute and relative cell references, 60% were 'competent', 10% 'introductory and 4% 'could not do much'. Most students perceived they were competent and had relatively good skills using spreadsheets.

Item Q13c concerned use of databases, giving a mean of 2.71 with an SD of 1.0. Responses indicated the majority of students felt they were less skilled using databases than all other

148

applications listed in Q13. The response rate was: 13% 'can't do much', 19% 'introductory', that is could create data files, enter data, and use simple queries to retrieve data, 37% 'competent' meaning they could create simple tables, use wizard to create reports and forms, and 21% 'highly skilled' and able to create a relational database. Overall nearly 70% of the responses indicated relative competence with simple databases. Approximately one third of respondents indicating relative incompetence with relational databases.

Item Q13d concerned investigating slideshows, the mean was 3.51 and SD of 0.7. There were 49% responses that indicated highly skilled, 24% responses indicated competent and 4% indicated introductory. That the majority of responses (73%) indicated they could create a master slide, including sound, print handouts and navigation buttons. They were competent enough to navigate during a presentation, add animations and transitions and insert hyperlinks, only 2% responses indicated lesser skills for these items.

Item Q13e was about the use of Email, the mean of the responses being 3.6 and SD 0.7: one of the highest means for Q13. Fifty five percent of responses were highly skilled, and 16% competent in that they could add a signature and attachments. Only 1% indicated they could not achieve much. Most students were competent and capable of emailing.

Item Q13f asked of Computer file management, achievement of the mean 3.53 and SD 0.8. There were 54% of responses indicating students were highly skilled having the capability to zip and unzip files, and install software. The other students (23%) could at least recognise different file types, navigate between drives and directories, and use help file. Two percent indicated having little confidence. Most students needed support in order to enhance good skills in computer file management.

Item Q13g concerned Internet use, the mean of responses being 3.72 and SD of 0.6. Sixty three percent of responses supported 'highly skilled', indicating the students could conduct complex searches, download and install plugins, use different browsers and alter browser preferences. At least 14% could save images and text, use advanced search tools, organise favourites and only 1% could only navigate to known web sites, create favourites and perform basic searches. This item was ranked highly by students in the survey with a strongly positive response.

Item Q13h questioned Webpage authoring, the mean being 3.08 with an SD of 1.0. 'Highly skilled' attracted 39% of responses 14% were 'competent' 20% were 'introductory', and 6% indicated 'can't do much'. However, most students had sufficient skills to set up a webpage.

Item Q13i related to Digital photography, the number of responses attracting a mean of 3.39 with an SD of 0.8. Most responses (64%) indicated that they progress to a higher level. Approximately 35% of responses indicated lesser skills for this item. They were generally capable of taking photos with a camera or video, and transferring images to a computer.

Item Q13j concerned using Image editing with a mean of 3.51 and an SD of 0.7. 'Highly skilled' attracted 50% of the responses the respondents being able to undertake complex image manipulation using filters and other special effects, 21% 'competent', and able to change format sizes, 7% being 'introductory, with (2%) indicating relative incompetence.

Item Q13k was about the use of video editing, the mean of responses being 2.92 and SD of 1.0. Nearly one third 27% of responses indicated that they were 'highly skilled'. A third 30% of responses indicated they were 'competent', 14% at 'introductory' and 10% 'can't do much' to this item; the rest did not response to these items. Most students showed capability in the basics of video editing software, with 27% believing they could employ advanced software as applied to complex editing and special effects in video editing. These student responses indicate a perception of a high level of capability in using digital video.

Scales from the survey - AIT students

Seven descriptive scales were constructed from sets of the closed items: eAssess, eAssessP, Apply, Attitude, Confidence, Skills and SCUse. Descriptions of the scales were given in Table 3.4. For each scale the score was calculated by averaging the score allocated across the items. Some item codes were reversed so that for all scales higher scores were more positive. The SCUse scale was an average of the five daily amounts for a week, Monday to Friday. Thus they did not have a reliability calculation.

The eAssess scale measured students' perceptions of the efficacy of the AIT exam and the use of computers to support it, by combining all the items E2a-k. The eAssessP scale, and question P2a-k items measured the efficacy of completing the Portfolio using the computer. The Apply scale measured students' applications of the computers by combining all the items in Q10a-f. The Attitude scale measured their attitude towards computer use by combining all the items in Q11a-e. The Confidence scale measured confidence in employing computers by combining all the items in Q12a-f . The Skills scale was a measure of self-assessment of ICT skills by combining all the items in Q13a-k. The SCUse scale estimated the amount of time

per day of computer use at school for a school week by combining all the items in Q8 (Monday to Friday).

Descriptive statistics for the seven scales are depicted in Table 4.2, and the graphs in Figure 4.2. show the distribution of scores. The reliabilities for the scales varied from a Cronbach's Alpha coefficient of 0.4 to 0.9. The eAssess, eAsssessP and Skills scales had high reliability coefficients with the other three scales being lower and therefore not adequately reliable. The SCUse scale was a simple average of the amounts of time each student spent in a school week; therefore there was no reliability calculation.

Table *4.2*
Descriptive statistics for the scales developed from the student AIT questionnaire

Scale	N	α	Min	Max	Mean	SD
eAssess	94	0.9	1.36	4.00	3.03	0.5
eAssessP	94	0.9	1.82	4.00	3.20	0.6
Apply	85	0.4	1.00	3.00	2.40	0.4
Attitude	82	0.4	1.80	3.00	2.70	0.3
Confidence	82	0.5	1.83	3.00	2.80	0.3
Skills	75	0.9	1.09	4.00	3.33	0.5
SCUse	94	-	0	360	79	67
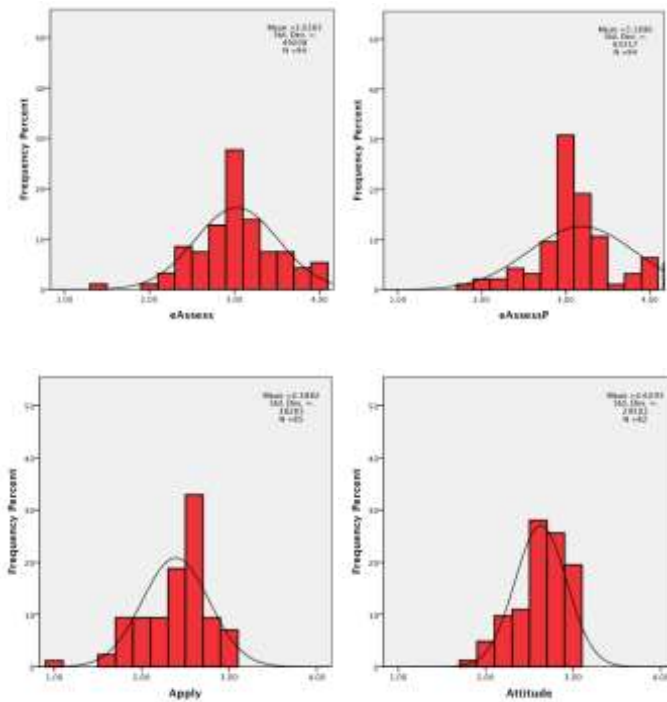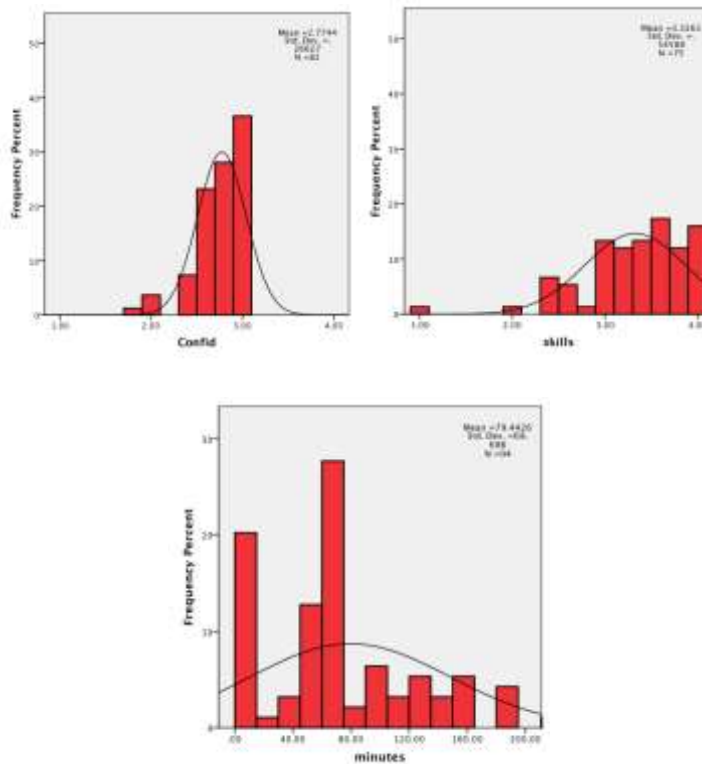
Figure 4.2 Distribution of scales

eAssess scale

The eAssess scale was developed from the eleven E2 items of the student questionnaire, which concerned the efficacy of the AIT exam and the use of computers to support it. Scores achieved were between 1 and 4. A total of 94 scores were analysed on this scale. Most scores (95%) were above the midpoint of 2.5, indicating a strong positive response. The mean was 3.0 and SD of 0.5, with a good spread of scores across the upper half of the scale. There were 13% of students who scored 3 and a larger number of students (30%) clustered around 3 on the scale, indicating they perceived the exam to have good efficacy, and was well supported by computer use. A reliability coefficient alpha of 0.9 indicated 90% internal consistency in the eAssess scale. Most students were positive about the AIT exam and generally perceived that using computers helped in completing the AIT exam.

eAssessP scale

The eAssessP scale was developed from the eleven P2 items comprising the student questionnaire, which concerned the efficacy of the AIT digital portfolio. A total of 94 scores were analysed on this scale. The mean approximated 3.2 with an SD 0.6; there was a slightly larger spread between the 2 and 3 scores on the scale, indicating the student cohort had more

152

positive perceptions about completion of the portfolio on the computer during the exam. Perhaps this occurred because the portfolio was completed in the student's normal class time, and not constrained by an exam environment, thereby giving students greater flexibility in the process. Most students were familiar with portfolios in their course because, in most cases, the activity was a familiar part of their school assessment schedule. This could have been reflected in their strongly positive attitudes and perceptions about portfolios.

Apply scale

The Apply scale was developed from the six Q10 items comprising the student questionnaire which was concerned with some computer applications. A total of 85 scores were analysed on this scale, giving a mean of 2.4 and SD 0.4. A relatively larger number of students scored 2.3 and 2.7 on the scale, indicating most students to employ a computer for most applications listed.

Attitude scales

The Attitude scale was developed from the five Q11 items of the student questionnaire; it concerned students' attitudes towards computer applications. A total of 82 scores were analysed on this scale. Giving a mean score of 2.6 and an SD 0.3. Most students scored above the midpoint of 2 on the scale, thus skewing the graph to the positive with little spread. This indicated most students to have a more positive attitude towards the use of ICT for assessment.

Confidence scale

The Confidence scale was developed from the six Q12 items in the student questionnaire which discussed student's confidence in using computers. A total of 82 scores were analysed on this scale with a of 2.8 and SD 0.3, with little spread. The graph was skewed to the positive with most students claimed to be highly confident in using computers.

Skills scale

The Skills scale was developed from the eleven Q13 of the student questionnaire; it eliced responses about the students' self-assessment of ICT skills. A total of 75 scores were analysed on this scale, the mean being 3.3 and an SD 0.5, with the measurements being very similar to those of the Engineering student research cohort. Both cohorts of students held a positive attitude towards and belived they had the necessary skills in deploying computer hardware

and software. Most students rated their level of skills between 3 and 4 on the scale for most of the computer application software listed in Q13, with the exception of Databases and Video editing. This was an indication that most students were less experienced with Databases and Video editing, these being skills not often required in normally in their learning.

SCUse scale

This scale estimated the time students spent per day for a school week using computers at school. The total of 94 scores analysed on this scale demonstrated a large range from zero time to 360 minutes per day students spent using computers at school. Students' average usage was approximately 75 minutes a day, a little more than that of the Engineering students.

Conclusions from responses of AIT students

Two assessments took place in the AIT component of the digital portfolio and computer-based exam. For the digital portfolio, students were required to complete it over four weeks in their class time prior to the AIT exam. This exam was completed in two-hours of class time. This section will draw conclusions from the AIT sample student, survey results about their attitudes and perceptions concerning the exam that followed compilation of the portfolio. Finally the students answered general questions about the application of ICT to learning and assessment.

AIT exam

In general students appreciated the manner and approach in which the AIT exam was conducted as evidenced by the high eAssess scale scores. They perceived the employment of computers supported the assessment, believing it was an appropriate assessment tool for the course. This was further supported by their overwhelmingly positive responses to the open response items.

On the whole students commented very positively on the ease of working on the computer-based exam compared to a paper-based exam. The exact perception of easiness varied but they frequently mentioned correction of errors and speed of typing compared to written examinations. Nearly all students perceived computers to be quicker and easier because indicating they could touch-type thus preferring a computer-based exam. Over 80% perceived that in the exam, the computer was good for graphics, reflecting on the design and so allowing them to show ideas more clearly. Most had highly positive attitudes towards the conduct of

the exam, believing it was more reflective of the AIT curriculum; hence they were able to use ICT more meaningfully to demonstrate the practical components of the course outcomes. This indicated students' positive attitudes and perceptions towards the exam, perceiving that the computer-based exam was appropriate for the AIT course.

Although most students allowed they had little familiarity or experience in completing exams on computers, 41% recoding ' no experience', approximately half of them felt they would need a little time only to become familiar with its use. Most students found the instructions for the exam easy to follow, this had helped them in developing their design ideas. Generally most of them felt they were able to show their skills in the exam completing it within the allocated time. However, the few who were less positive tended not be familiar with the computer-based exam, but given a little time and practice they would be more positive towards accepting it. Most respondents asserted the type of exam allowed them to pursue that were more relevant to the course work and more efficient. They considered the exam could more easily be completed because they could touch-type more easily.

Generally it could be concluded from the student survey responses that the AIT exam was well received. The results indicated them to be highly positive, having an appropriate attitude towards computer applications, valued ICT support of a computer-based examinations for summative assessment in the course.

AIT digital portfolio

In general students appreciated the manner and the approach in which the digital portfolio was implemented as evidenced by the high eAssessP scale scores. This indicated that most students had a highly positive attitude towards the digital portfolio. They perceived completing the digital portfolio using computers as helping them to show their design processes more succinctly, and the method was appropriate for assessing a practical course. Further support for the above conclusions came from the overwhelmingly positive responses to the open response items.

Nearly 73% of students agreed to having some experience with digital portfolios and, it would take them some time to become more proficient. Over 85% of students thought the digital portfolio allowed them to show their capability; therefore it was preferable to pen and paper assessments. They believed they could demonstrate the 'Technology process' more concisely when using the digital portfolio. Comments from students on the open-ended responses

included: 'It was easy to setup and put my work into one portfolio', and 'It was easy to access all my files because it was much more organised' thus indicating strongly positive attitudes about the digital portfolio application. Students who completed their portfolio found it easy to produce and satisfied with its results in assisting to design the digital portfolio. They could develop designing skills more quickly than in a paper-based exam. The open-ended responses showed these were easier to set up and access, store and sort in a digital portfolio because it enabled better organisation.

The students showed greater familiarity with the digital portfolio than a paper-based exam. Students' attitudes towards and perceptions about the type of exam were a little less positive compared those of the digital portfolio because they had more practise completing digital portfolios in their course work. This could have influenced students' attitudes towards, and perceptions of, the digital portfolio. However, the high mean score in the eAssessP scale indicated most students to have a highly positive attitude towards the digital portfolio.

Overall perceptions and attitudes towards use of ICT

Overall it was concluded that the majority of students were strongly positive about the value of ICT to support assessments, concluding they were skilled and confident in the use of ICT. The results from the student survey data revealed significantly high measures in the Skills scale, which were highlighted by a positively skewed, high mean. This was considered generally to reflect their attitudes towards, and perception of the skills in ICT applied while completing both the exam and the portfolio. Most students' average computer usage reflected in the SCUse scale to be approximately 75 minutes a day; this was inferred as revealing their positive about the value of ICT in their course. The high means and positively skewed distributions for the Apply, Attitude, and Confidence scales similarly indicate their acceptance of ICT support for assessment in the curriculum. A small number (2%) of students who had negative attitudes about the use of ICT. Perhaps they needed support and coaching as they had little or no experience with computer-based exams.

Overall the analysis of the data revealed the students' positive attitudes towards the value of using ICT to support computer-based exams for summative assessment in the AIT course. These values were also evident from the students' interviews and the observation of their work in classes. The latter will be discussed in the case studies featured in chapters five and six.

Comparisons between Engineering and AIT students

This section compares the similarities and differences between the results from the Engineering Studies and AIT students' surveys. Both took an exam so that their attitudes towards computer-based exams could be compared. Both cohorts had limited experience in completing computer-based exams. When compared, both student samples on the eAssess scales had means 3.2 for Engineering Studies and 3.0 for AIT with similar spread in each sample. Both scores were above the midpoint of 2.5. with no differences in the results. They felt the assessments were easy, being certain using computers helped them in demonstrating their skills.

In general, Engineering Studies students spent less time 58 min compared with 79 min for AIT students) relating directly to computers in their course work however, their attitudes and perceptions of the Engineering exam compared to that of AIT students were relatively similar. They were not daunted by the Engineering exam, being as positive about it as were the AIT students. However, the only slight differences (0.10 difference in means) between these two groups were in the Skills scale and concerned students with little or no experience with computers. There were relatively a little more (around 10%) Engineering students, approximately 10% who they had no experience and needed additional time to develop their computer skills. These students were just as strongly positive in their attitudes and perceptions towards the value of ICT in supporting their assessments.

Both Engineering Studies and AIT students had access to all the devices listed in Q5 items; however an average 74% of Engineering Studies students used one or more devices compared to almost all the AIT students. This may be due to the differences in their course work an engineering workshop component being necessary in Engineering Studies thereby requiring some of the devices listed.

Approximately three quarters of the students had access at home to the technologies listed. Two thirds of them possessed a laptop computer and 81% had broadband Internet connection. At school they used computers for 79 minutes per day and 72% indicated use of a computer at home most days. However the frequency of computer usage at home for Engineering Studies and AIT students was relatively similar.

Engineering Studies students completed their exam on EeePC wherein skills for using a webcam were essential in one activity the task required and with which some students experienced difficulties. This occurred with one of the devices all students used least. AIT

students completed their exam on the school's desktop computers, with appropriate software applications for the exam available in those computers.

Students using the EeePC intimated that the computer screen and keyboard were too small. This however did not hinder them in completing the exam. They indicated high confidence in their skills with ICT as shown in the high Skills scores. Results from both samples indicated that all student's attitudes towards and perceptions of ICT supporting assessment were positive. It is most likely these students valued the support of ICT in their courses.

Summary

This chapter discussed the results from an analysis of student survey items and the scales developed from groups of items within the questionnaires. Although this study focused mainly on qualitative data, some quantitative analysis was conducted prior to seeking themes and trends that had formed the students' attitudes and perceptions. The discussion was about students' attitudes and perceptions about computer-based exams for Engineering Studies and AIT were discussed, in particular the use of ICT for learning and assessment. Both groups of students completed a computer-based exam in their school's computer lab. For AIT students, apart from the exam, digital portfolios were to be completed in class time prior to their exam. The portfolio was a means of giving students the opportunity to express more fully their attitudes and perceptions about accepting the value of ICT in completing the challenge. This also aided the drawing out of themes related to student attitudes and perceptions about the use of ICT to support assessments and ICT itself. These analyses were presented in this chapter.

From the sets of the closed-response items, six descriptive statistics scales (eAssess, Apply, Attitude, Confidence, Skills and SCUse for Engineering Studies), and seven descriptive statistics scales (eAssess, eAssessP, Apply, Attitude, Confidence, Skills and SCUse) were created for AIT students. The distribution of scores and scales were generated using Cronbachs Alpha reliability coefficients, and means and SD for comparing the statistical relatedness of items and scales and as such Alpha reliability coefficients is not used in terms of distribution.

Two open-ended response items were deployed for Engineering and four for AIT and the responses were tabulated to assist in drawing themes from students on the two best and two worst things about the exam and compiling the digital portfolio. These gave students the opportunity to express fully their attitudes and perceptions about the value of ICT to support

assessments relative to experience and knowledge of computer technology. This provided greater scope for triangulation of data collected from the closed items in the student survey.

The eAssess and Skills scales from the results indicated strongly positive attitudes and perceptions from the Engineering Studies students, and the high coefficients supported the reliability of the results for both scales. The remaining three scales had lower Alpha reliability coefficient and thus were considered less reliable. Similarly for AIT students' results from the eAssess, eAssessP and Skills scales indicated strong positive attitudes and perceptions of students for the AIT exam, digital portfolio and Skills with ICT.

In the next two chapters, five and six, present case studies based on teacher-class groups for both Engineering Studies and AIT, probing attitudes and perceptions of students and teachers ICT to support assessments in their courses. The findings from each of these cases with respect to similarities and differences will be discussed in chapter five for Engineering followed by chapter six for AIT case studies. Their attitudes towards and perceptions of ICT to support assessment in both the Engineering Studies and AIT courses, and the employment of ICT for learning and their perceived skills with ICT in the curriculum will be the focus in these chapters.

CHAPTER FIVE:
ENGINEERING CASE STUDIES

This chapter presents the data analysis on a case-by-case basis for each of the five schools at which the Engineering Studies exam was implemented. For each case the background is discussed prior to a presentation of the results of analysis of the data from the observations, student survey, forum, and teacher interviews. The discussion will also focus on the descriptive statistics generated using six scales eAssess, Apply, Attitude, Confidence, Skills, and SCUse derived from sets of items of the student survey. At the end of each of the five Engineering case studies, the results of analysis of all data are combined to complete a CBAM analysis for the teacher, followed by a set of conclusions. This document makes reference to "the effect size" when comparing the research cohort to the *'total population'* of all Engineering Studies students in WA. The analysis of data for each case study, information relevant to all classes is now presented.

The researcher visited each teacher a number of times for each case before their students became involved in the project. These visits were to discuss the research processes and to decide the classroom and date during the school term was most appropriate for each teacher and their students to do the exam. It was also appropriate to check and test the technologies required, in particular to decide which form of the e-Scape system needed to be used: 'Live', 'Intranet' or USB drive. In some cases photographs of the room in which students would complete the exam were taken. The final visit occurred on the day of the exam when the researcher conducted the exam tasks and collected qualitative data.

A summary of background information for each case study was given in Table 3.1 for the Engineering Studies course.

Case Study GE: Private School

The GE case study involved one class of Year 11 students completing the Engineering Studies course Units 2A-2B. Fifteen students in the class were studying the Mechanical Engineering specialisation, working on a range of mechanical projects.

Implementation, technologies and issues arising

The form of e-Scape system applied at this school was linking 'live' to the Internet, so a number of checks needed to be made to ensure that the students could log into the appropriate URL to access the examination; thus hardware devices were tested for connectivity. The room selected for the examination was a computer lab, having computers placed around the walls of the room with some worktables in the centre. This was an ideal set-up for the examination as students could do their modelling work on these tables. No photo of the room was taken for this case.

Results from data analysis

A range of data was collected and analysed, including observation of the classes, an interview with a group of students, an interview with the teacher, and a survey of the students. The results of the analysis of each of these data sources for this case study are each discussed separately below. A summary based on all sources of data is provided as a CBAM analysis which provides conclusions.

Observations of the Class

Members of the research team visited the class conducting the assessment task and collecting qualitative data. Students in this group were paired, for example student 111 with 122. They worked on the school computers in the laboratory, logging on to the server to access the exam.

The exam was conducted on a morning, the students arrived and waited for instruction to move into the lab. The 15 students in this class were allocated a student ID to logon. The researcher wrote the URL on the whiteboard and instructions and activities were given to students. The exam commenced fairly smoothly, except for a few minor glitches with two students mistyping the URL. All students worked well and appeared keen on doing their design on the computer. Some questions were raised by students regarding the use of the

162

webcam as they were not accustomed with this device. Some user errors were related to opening of files and mistyping of file names. The computer network was slightly slower than anticipated in loading and accessing some files due to the bandwidth rather than students' workstations or peripherals.

Overall, this form of assessment positively engaged the majority of students in this class, all being observed as working steadily on-task for the whole time.

Survey of Students

Fifteen students in this class completed the closed and open items in the survey. The results of analysis of each item are discussed in this section. A summary of descriptive statistics results for the closed items appears in Appendix H.

Closed items

For item E1a, two students (GE101 and GE112) indicated they had previously done many exams on a computer. Only two students (GE109 and GE114) indicated they had done none, student GE114 saying he needed much time to get used to the procedure. The other eleven students indicated they had some previous experience in completing a design project exam on a computer. The majority of these students indicated they needed little time to get used to the process (E1b). Although the class means for both E1a and E1b were slightly above the population mean, effect sizes were between absolute values of 0 and 0.2 indicating they were not significantly different to that of the population.

For E2 items, most students were positive about the value of using computers in doing the Engineering design project. Students' responses to E2 items indicated they were more likely to be confident and positive towards accepting computer-based assessments. Item mean difference effect sizes were between absolute values of 0.1 and 1.0, seven items having absolute effect sizes above 0.5 (E2b, c, d, f, I, j and k), which indicated that, on average these students had a relatively more positive perception of using the computer in developing, recording, modelling and compiling design ideas. Overall they felt able to show what they could do better using computers for the design project in the exam. This showed these students seemed to be more likely to appreciate the value of a computer-based exam in the Engineering course. Triangulation with other analysed data validated this finding about their attitudes and perceptions of the efficacy of the computer-based assessment.

For Q5 items, most students used between three and six devices at home, ranging from computer, digital camera, vdeo camera, MP3 player, laptop, game console, mobile phone and webcam. Three students (GE103, GE112 and GE115) indicated they used all the devices. Item effect sizes were between absolute values of 0.1 and 0.5. showing these students were not significantly different to the population with the use of various computer technologies at home.

For Q6, all students in this class indicated they had access to broadband Internet, with the exception of student GE105 who employed Dial-up Internet. These students were similar to the population with the type of Internet access at home.

For Q7, students indicated they used a computer most days at home, with the exception of four students (GE105, GE108, GE109 and GE111) who indicated they used a computer more than once a week. An effect size of 0.04 showed that these students were similar with computer usage to the population.

For Q8, students spent an average of 83 minutes each day using computers at school. Student GE114 indicated he only used computers on Fridays and only spent ten minutes using it at school. The class mean was much higher than the population mean, with an effect size of 0.61 indicating these students spent relatively more time a week using computers at school compared to that of the population.

For Q9, nine students indicated they did not touch type and only six students in this class touch typed using all fingers. These students were relatively similar to the population, although were larger numbers of students who did not touch-typewith all their fingers.

For Q10, items all students in this class indicated using a computer to type their assignments at school (Q10c). Most students used a computer to do most of the tasks listed with the exception of drawing a diagram or picture (Q10b). However item effect sizes were of absolute values between 0.1 and 0.6 indicating these students were relatively similar to the population with their usage of the various computer software applications listed.

For Q11, items most students' responses to all items listed were positive. Eleven students felt computers helped and made their work at school easier, whilst three students found that sometimes computers made their work at school more difficult. Item effect sizes were absolute values of 0.1 and 0.3 indicating these students to be relatively similar to the

population in terms of attitudes and perceptions towards the value of using computers at school and at home.

For Q12 items, students indicated they were generally confident and usually did well with computers, with the exception being for Q12f wherein two students (GE107 and GE113) felt that using a computer was very difficult for them. Item effect sizes were absolute values of 0.1 and 0.2 showing they were no different and were relatively similar to that of the population in confidence with computers.

For Q13 item, students in this class indicated having the skills to use most of the computer software listed effectively. Four students indicated they could not achieve much with Databases, and three indicated they could not understand much about Webpage authoring. Item effect sizes were between absolute values of 0.0 to 0.4 indicating these students were relatively similar to the population in terms of their skills with the types of computer software listed in Q13 items.

Open-ended items

Students responded to two open response items to indicate the two best and worst things about the exam (see Appendix L).

For the two best things, students considered using computers to make tasks and enjoyable. Also computers provided a better learning environment, allowed access to more information and tools, being easy to manage and move things around in ways they could use their skills to demonstrate their ideas. Most students enjoyed using the computer for the exam, thinking it was fun and welcomed this experience. One student commented that this method of assessment was more practical, another that a paperless exam was much more appropriate with current use of technology, while yet another said there was no need to flip page after page, backwards and forwards when referring to a particular question or item in the exam. These comments and remarks demonstrated that students were generally in favour of these types of assessment and had a positive attitude towards them.

For the two worst things, students were concerned about some hardware and software issues. One student (GE101) raised concerns about ergonomics within the 3-hour duration. Three students (GE103, GE104 and GE106) experienced poor picture quality with the webcam. Six students (GE103, GE106, GE107, GE110, GE111, and GE113) were concerned with the lack of time to complete the exam in 3 hours. Most of the concerns were about minor hardware

technological malfunctions and adequately managed on the day. On the whole all students were being able to complete the exam within the 3-hour period.

Questionnaire Scales

Six scales were derived by combining items from the questionnaire (see Table 3.3, Chapter 3). Descriptive statistics for these scales for this case are shown in Table 5.1 and graphs in Figure 5.1. Then the results for each scale are discussed separately.

Table 5.1
Descriptive statistics for the student survey scales for the GE class

Scales	GE Class					Population		Sample
	N	Min	Max	Mean	SD	Mean	SD	Effect Size
eAssess	15	3.09	4.00	3.40	0.25	3.16	0.50	0.48
Apply	15	1.80	3.00	2.41	0.50	2.38	0.38	0.08
Attitude	15	2.20	3.00	2.75	0.23	2.63	0.32	0.38
Confidence	15	1.83	3.00	2.80	0.30	2.77	0.29	0.10
Skills	15	2.45	4.00	3.17	0.54	3.27	0.47	-0.21
SCUse	15	2.00	240	88	56	58	50	0.61
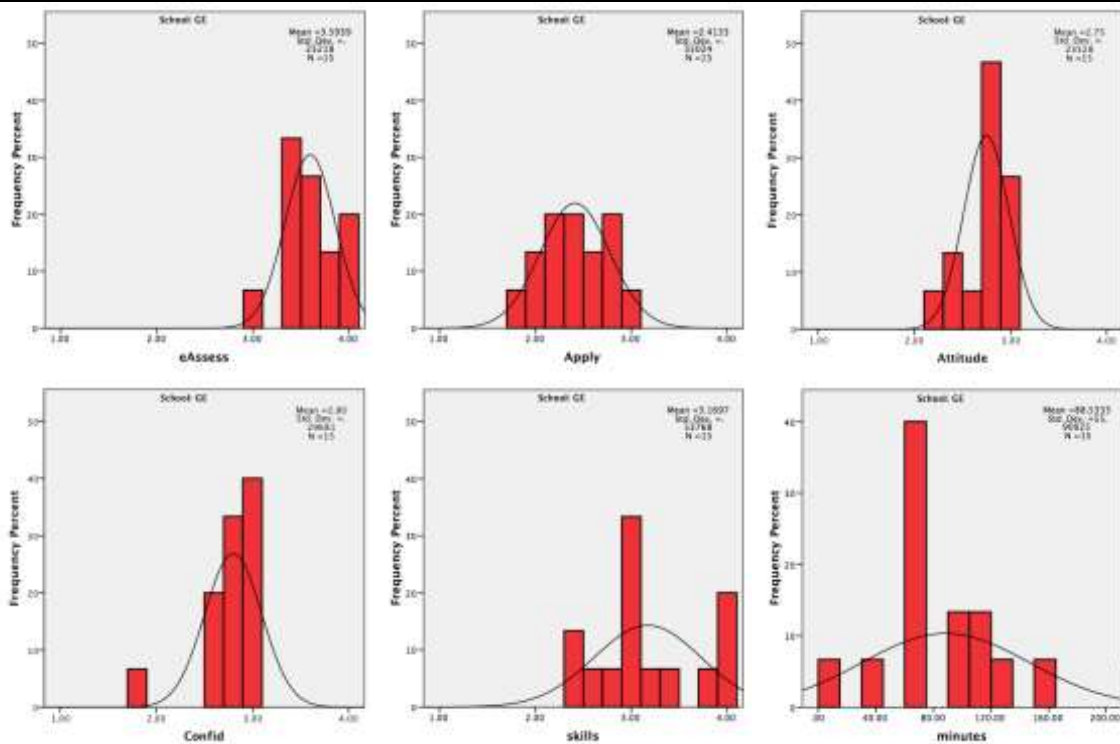
Figure 5.1 Distribution of scores for the student survey scales for the GE class

166

The eAssess graph shows most students having scored between 3.00 and 4.00 with a mean of 3.40, well above the midpoint of 2.5, and a standard deviation of 0.22. Little spread was noted and the graph was skewed positively, indicating that these students tended to have positive attitudes and perceptions towards the efficacy of using computers in the assessment. This was probably due, in part, to most students in this class having previously accomplished some design projects on a computer, thereby having had some familiarity with the process. They were able to complete the exam with ease with the help of the computer. An effect size of 0.48 indicated this class was generally slightly more positive than the population about the efficacy of using computers for the assessment.

The Apply graph showed that most students scored between 2.00 and 3.00 with a mean was 2.4 and SD of 0.5, a reasonably normal distribution, with most students around the midpoint. This indicated they tended to apply computer applications in the range of contexts listed in Q10. An effect size of 0.08 indicated they were relatively similar to the population.

The Attitude graph was skewed positively and showed most students scored above the mid-point of 2.5 with mean of 2.75 and SD 0.32, an indication that were likely to have a positive attitude towards using computers in and out of school. An effect size of 0.38 showed they were at least as positive, if not more so, towards using computers compared with the population.

The Confidence graph was skewed positively showing there to be little spread within this class with SD being 0.32. Most students scored above the mid-point of 2 and a mean of 2.80. An effect size of 0.10 indicated that they were as confident as the population in using computers.

The Skills graph showed most students scored above the mid-point of 2.5 with a smaller number of students scoring around the maximum of 4.00. This indicated their perception of ICT skills to be relatively higher. The mean of 3.17 was slightly below the population mean but the effect size of -0.21 indicated they were very similar to the population on the measure of ICT skills.

The SCUse graph showed a large number of students spend less than 80 minutes on any one-day using computers at school. However, the mean of 88 was relatively higher than the population mean of 55. An effect size of 0.61 indicated that, in general, students in this class spent relatively more time than the population in using computers at school. This probably also explains some of the high eAssess scores previously noted.

GE engineering students forum

For the forum students sat in a semi-circle in a classroom; a transcript of the discussion is included in Appendix D.

The students explained they were basically happy using the computer in designing their project in the exam. They believed using the computer to design their project was a meaninful reflection of the curriculum; it was appropriate technology for the assessment. They considered the manner in which the exam was conducted gave them the opportunity to express their ideas more succinctly; thus they were able to demonstrate process in the production of the required task. They demonstrated the Technology Process that was adequate for one of the required outcomes for this course. Additionally they could easily edit their work and demonstrate a range of processes and ideas.

A close reading of the transcript indicated they enjoyed the voice recording of their reflective section of the task and believed such assessment was realistic and suitable for the Engineering Studies course. The task set of building the water recycling system was appropriate for computer modelling, not just pen and paper becase this is what the real engineers do in the real world. They contended the tasks were completed more quickly on the computer than if using pen and paper. Throughout the exam students were happy and enjoyed using the computer for designing their project, some mentioning that it was much quicker and easier than in their normal class using pen and paper in their design process.

Some suggestions for improvement were made, for example, the student cohort would prefer a larger screen for displaying multiples pictures of their model from different angles (activity box 15, Photos of Model). The USB web cam technology could also be improved and there were moments when the webcam froze and the computer/s needed re-booting, which led to lost time for student work.

Overall the students liked the assessment and did not consider the technical problems encountered a major issue since, as time proceeds, there will be improvement as ICT improves.

Pre-interview with the GE teacher

The teacher provided feedback by way of an email return to a set of questions forwarded prior to his class being involved in the assessment (Appendix G). The following is a summary of responses to the questions.

The teacher indicated that his students employed computers for assessment purposes. Regarding Q5, he was keen implement this type of assessment for his students as he was a regular user of ICT in his lessons. He had used programs such as Crocodile Clips, Bridge Builder and CAD in designing class activities, applied ICT in creating simulation tasks, and in problem solving exercises. He reinforced student learning with ICT, wishing his students could utilise computers in their learning for 100% of the time. He was positive about using such technology for assessment and would like to see a consistent approach across all learning areas in the school. He believed the effects of using computers for assessment in his program had potential for developing a consistent application of ICT across the whole school. He was keen to engage other teachers in the use of ICT by adding programs to the school's 'Shared drive' and would continue to promote digital forms

Post-Interview with the GE Teacher

The teacher provided feedback by way of an email return to a set of questions after his class completed the assessment (Appendix J). The following is a summary of responses to the questions.

The teacher commented that his students responded well to the style of the content and process of the exam, all students being able to complete the requirements of the exam in the 3-hour time frame. His students indicated attitudes that they were keen and ready to embark on using ICT in their Engineering Studies course of study. He said the students responded well to the use of a computer in designing the project. He believed the structure of the exam was meaningful and relevant to a practical course such as Engineering Studies, commenting that his students enjoyed the exam and would prefer this form of assessment to the traditional pen and paper exam.

The teacher indicated a positive attitude and a willingness to support developing the use of digital forms of assessment, commenting that his students generally preferred ICT assessment to a theoretical, paper-based exam. He would prefer the timing to be more controlled, believing the timing was generous, most students having ample chat time between instructions to move onto following tasks. He would have preferred more time for students to familiarise themselves with the equipment for the task so that they could have performed even better. He realised students encountered some difficulties with the webcam capturing images of their sketches, knowing they would have preferred a higher resolution capability webcam for the exam. Overall he felt the exam was conducted successfully.

CBAM analysis

The results of the analysis of data from the previous sections were applied to make judgements on the three constructs of the Concerns Based Adoption Model (CBAM):– Innovation Configuration (IC); Stages of Concern (SoC); and Levels of Use (LoU). These were employed as a diagnostic tool for analysing this teacher's implementation of digital forms of assessment. The outcomes of these judgements along with summaries of the evidence supporting them are provided in Table 5.2. The numbers in the judgement column are the CBAM Innovation Configuration in Appendix A.

Table 5.2
Judgments for the GE teacher on the CBAM Constructs

Construct	Judgement	Evidence
IC		
Access to ICT to support Assessment	(1) Teacher has access to ICT to support assessments at all times	Teacher had access to a computer lab and the Internet. He was timetabled into a computer lab for his entire Engineering course delivery. He had opportunities with ICT to assessments.
Digital Forms of Assessment	(3) Teacher uses no alternative ICT digital forms of assessments with his courses.	Teacher might have considered the possibility of digital forms assessments, but was only exploring not using these forms. He could be considered as in the early stages with the innovation.
ICT and Pedagogy	(2) Teacher uses ICT for some teaching activities	Teacher had used programs such as Crocodile Clips, Bridge Builder and CAD in designing class activities/tasks.
SoC	(2) Personal	Teacher organised a team of facilitators regarding the use of online programs, which engaged ICT in student work, but not for assessment. He involved other staff members and sharing ICT resources on the school's Shared Drive.
LoU	(2) Preparation	Teacher indicated he reinforced student learning with ICT and he believed the effects of using ICT for assessment with his students could influence a consistent application of ICT across the school. However, at this time he just implemented the assessment for this study.

Conclusions about the attitudes and perceptions of the GE Teacher

In this section the discussion centres on the summary of CBAM the judgements of the set of attitudes and perceptions of the GE Teacher.

Attitudes and perceptions towards using ICT to support assessment

The teacher had access to ICT to support assessment at all times. He believed that by working with other staff members for them to apply ICT for assessments in the school promoting ICT

across the learning areas could be assisted. He believed in engaging students in using ICT because they would appreciate more the value of ICT to support assessment. He commented in the interview (Q11) that the application of ICT could be limitless, in terms of enhancing students' innovations, hoping ICT could support assessment in the Engineering Studies course. He admitted using ICT hitherto for learning rather than assessment.The teacher agreed ICT could support digital forms of assessments, it being a meaningful way in providing feedback to students, especially the design process wherein students are required to demonstrate the process in performance-based tasks. He was aware ICT supporting assessments was valuable, there was not sufficient evidence of him using it in Engineering classes.

Attitudes and perceptions towards ICT, pedagogy and the course

The teacher believed the delivery of the Engineering Studies course had a high content of practical components, feeling that using ICT helped him in his preparation of teaching resources. He focused on appropriate ICT tools to support delivery of performance-based curriculum, believing the application of ICT in course delivery could relate more to the majority of students if its versatility could be demonstrated and the pedagogy had engaged students meaningfully with the tasks.

In general the teacher believed that the more awareness of the use of ICT in the course, the more likely it would have a positive impact on his peers within his faculty and across learning areas in the school. He felt that ICT in the course accurately reflected the nature of the practical components of the tasks required. He had a positive attitude towards the use of ICT in the Engineering Studies course.

Attitudes and perceptions towards ICT supporting the Engineering Studies exam

The teacher supported the use of digital forms of assessment for the exam, indicating it was appropriate to measure such performance through this means rather than a paper-based examination. He noted the students were given the opportunity to show their skills and experience with the use of ICT in completing the exam. ICT application also accurately reflected student learning.

The teacher reported being peddagogically content and keen to see this type of assessment continue. He commented that these forms of assessment should be carried over to other

courses of studies. He had a strongly positive attitude towards the conception of using ICT to support the Engineering Studies exam.

Conclusions about attitudes and perceptions of the GE Students

This section discusses the summary of results from the student survey and forum about the attitudes and perceptions of the students.

Attitudes and perceptions towards using ICT

Overall, analysis of the data from the student survey showed most students in this class to be keen users of ICT. They employed ICT on a daily basis for communication and social networking. They believed ICT was the 'norm' for work and play, it being good for the world. Generally these students were comfortable with, and had a positive attitude towards ICT. Along with the teacher, most students agreed to having relatively high levels of confidence and skills with ICT.

Attitudes and perceptions towards ICT and learning in the course

These students were generally happy and had a positive attitude towards deploying a range of technological devices for their learning. Most accepted ICT should be part of their learning experience. These students acknowledged that ICT was part of their learning experience in the course being studied and they were not daunted by it. Students participating in the forum agreed ICT was appropriate for the Engineering Studies course. They felt using ICT for their course work was more appropriate than using pen and paper.

Attitudes and perceptions towards ICT supporting the Engineering exam

The students indicated implementing the design project was very different to learning activities in class. Only two students had no previous experience or exposure to a computer-based exam. However, a few students encountered issues with the timing of moving from one activity to the next. The use of the webcam and recording their design ideas was new to most students, but they were happy and positive about deploying a range of technological devices. The student survey results were illuminating for they enjoyed employing these interface devices and appreciated the relevance of such technologies for completion of the Engineering Studies exam. In the final analysis, they had a highly positive attitude towards ICT supporting the Engineering Studies exam.

172

Case Study HE: Public School

The HE case study involved two classes of Year 11 students completing the Engineering Studies course Units 2A-2B. There were twenty-one students in the combined classes who participated in this assessment task, 13 students in one class and 8 in the other, studying the Systems and Control specialisation, the project they were studying in this course was the design of an electronic smart vehicle.

Implementation, Technologies and Issues Arising

The form of e-Scape system used at this school was linked 'live' to the Internet, so a number of checks beforehand were made to ensure the students could log into the appropriate URL to access the examination, and that the webcam peripherals were activated. Two rooms were selected for the examination, one an electronics room (see Figure 5.2) which had computers in the centre of the room and the surrounding two inner walls of the room and being equipped with soldering stations for electronics projects; and the other a computer lab adjacent to the electronics room. The latter had computers setup in the centre of the room; however no photos were taken of this room.

Results from data analysis

A range of data was collected and analysed, including observation of the classes, an interview with a group of students, an interview with the teacher, and a survey of the students. The resulting analysis of each of these sources of data for this case study are now discussed separately. The summary closes with a collation based on all sources of data provided for the CBAM analysis and its conclusions.

Observations of the class

Members of the research team visited the class conducting the assessment task and collecting the qualitative data. Students were working on the school computers and logged on 'live' to the e-Scape server in two adjacent computer rooms. The two research facilitators, one in each room, were also logged on as the examination managers, hence being able to monitor each logged-in student's progress throughout the examination tasks, and being able to stop or extend a task if necessary. In the Electronics room the computers were set in rows across the room. This was not the ideal set-up for the examination as the table space for students on

which to conduct their modelling activities was limited, this room being mainly setup for electronic and soldering activities (see Figure 5.2).

Figure 5.2 A photo of part of the HE Electronics Room

In this school examination activities were conducted simultaneously with the two groups which were logging on simultaneously to the e-Scape server. The normal difficulties encountered, such as, students logging on incorrectly, and poorly performing computers were multiplied two-fold with the two groups. This led to a disruptive start to the examination, waiting for all the initial difficulties to be dealt with before commencement.

During the exam minor technical problems occurred with the use of the webcam and audio recording for a small number of students; however these were addressed quickly. Some students found the sketching exercise challenging as they had previously used to pen and paper; thus completing their sketching digitally was very different proposition. The timing of individual activities caused some concern for students who were able to complete their activities quicker; they had to wait for the others to complete before moving onto the next activity. An issue arose concerning keeping these students occupied so that they did not become behaviour problems.

Survey of Students

Twenty-one students in this case study completed the closed and open response items in the survey. Their responses to these items are discussed in this section. A summary of descriptive statistics results for the closed items is listed in Appendix H.

Closed items

For item E1a, eight students among the twenty one of this cohort participating (HE101, HE103, HE104, HE105, HE106, HE109, HE115 and HE121) indicated they had previously completed many exams on a computer. Four students (HE107, HE112, HE114 and H E120) indicated that they had no previous experience, and the remianing nine students had some. Most showed a high degree of familiarity with computer-based exams. However, for Item E1a they were less positive than the population with seventeen students indicating they needed more time to become competent in designing a project on computers. Comments also were made about more time being needed for familiarity with specialised applications such as web authoring, video editing and drawing with a mouse.

Environmental factors such as the school's computer network infrastructure and network data transfer capability, together with this new examination process could have also influenced students' responses. Some students felt that conforming to strict timing protocol for each step in the exam process hindered their progress. This was a concern of several students (HE104, HE109 and HE117) who completed the activity quicker than some but were not allowed to proceed with the next activity; they lost concentration during this period of waiting. The class means for both E1a and b were slightly below the population mean 2.33 and 2.62. Item effect sizes were absolute values of 0.1 for both E1a and b, indicating these students measured similarly to that of the population.

For E2 items most students were as positive as the population about the efficacy of the Engineering exam. The only exceptions were with students (HE106 and HE107) who indicated that the computer was not good for recording their modelling and design ideas. Student HE107 also indicated that overall he was not able to show his ability in designing the project. Item effect sizes were between absolute values of 0.1 and 0.6. However, five items, E2a, c, d and e, with effect sizes between 0.5 and 0.6, indicating that, although they were a little less positive, overall they were similar to the population their concern about the efficacy of completing the Engineering project using a computer.

For Q5 items, four students in these classes indicated they used all the devices listed at home. Eight students (HE102, HE105, HE109, HE113, HE116, HE118, HE119 and HE121) revealed they used most of these items. The least used items by these students were the video camera and the webcam. The mean for most items in Q5 were mostly above that of the

population, and the item effect sizes were between absolute values of 0.1 and 0.4, which indicated these students to be relatively similar to that of the population.

For Q6, all students indicated they had access to broadband Internet at home. They accessed the Internet frrquently, an effect size of 0.04 showing they were similar to the population in terms of Internet access at home.

For Q7, nineteen students indicated they used a computer on most days at home. Student HE105 was the only student indicate he rarely used a computer at home. Effect size of 0.11 revealed them to be no different to the population with computer available at home.

For Q8, three students (HE114, HE115 and HE121) were the exceptions who indicated computer use above the class average of 54 minutes in a week. Absolute item effect sizes of between 0.0 and 0.2 showed them to be not much different to the population on the average amount of time spent using computers in a week.

For Q9, fourteen students indicated they touch-typed with all their fingers, six students did not, and one student did not respond. Although there were more students in this class who touch-typed, their effect size was relatively similar to that of the population.

For Q10 items, students' responses were generally positive about computer use to type an assignment for school (10c), doing line or pie graphs (10d), sending letters (Q10e) or utilising sites like MySpace, Facebook and YouTube (10f). However eleven students were outliers who indicated they would not keep a list of addresses of friends (Q10a). Likewise these eleven students revealed they could not draw a diagram or picture using a computer (Q10b). Item effect sizes of absolute values were between 0.1 and 0.4 indicated these students to be similar to the population in terms of these applications of computer use.

For Q11items, most students were positive about the use of computers. They enjoyed using them at school and at home to do their schoolwork. Fourteen students indicated that computers were good for the world, while seven indicated computers were good for the world sometimes. They liked exploring matters for themselves instead being told by the teacher. They indicated contentment, having positive attitudes and perceptions about learning with computers. Absolute item effect sizes of between 0.1 and 0.3 reflected that they were similar to the population.

For Q12 items, most students felt confident and reltively expert at using computers (Q12a and Q12b). They indicated happiness when challenged to solve a new problem using a computer

(Q12c and Q12d). Five students believed they could not learn to program a computer (Q12e). Obviously they were less skilful and less confident in programming thereby feeling no need to learn programming. Overall the students were confident in utilising computers and comfortable in trying out new programs in solving fresh problems. Item effect sizes of absolute values were between 0.0 and 0.3 showing they had similar levels of confidence with computers to the population.

In Q13 items, most students evinced a high level of skill in using computer applications. However, a few students showed lower levels of skill for databases, webpage authoring and video editing (Q13c, h, and k). Eight students indicated confided they could not use Databases (Q13c). Four students (HE105, HE116, HE119 and HE120) revealed they could not undertake Webpage authoring (Q13h). Four students (HE110, HE113, HE119 and HE120) indicated they could not understand Video-editing (Q13k). Although none of these latter skills were required for the exam, such skills could be advantageous across all computer applications. The absolute item effect sizes were between 0.0 and 0.5 indicating that, on average, this research cohort was similar to that of the population regarding their skills with ICT.

Open-ended items

Students responded to two open response items asking the two best and worst things about the exam. A summary of responses is given in Appendix L.

The two best things students considered were the use of computers made the assessment task easier and enjoyable. Student HE108 commented it to be a more practical way of using technology; this was a potential change in this exam. He considered this to be a positive move towards ICT supporting assessment. Student HE110 said it opened possibilities for the Engineering Studies course. Student HE115 commented that it was quicker and easier to type as opposed to writing; it also gave him more time to develop his ideas and was fun and interesting. Student HE119 found using a video to be a new idea for him and that he welcomed it being easier to capture an image. Most students were happy and enjoyed the exam with some students indicating they would like to see all Engineering exams conducted in this format.

For the two worst things the following comments were made by HE105, 'encountered many technical errors', and HE119 averring, 'unpredictable and frustrating and I feel limited when using a computer'. This concern was about utilising a text editor 'the text box' within the

software program. They found it hard to use the font tools properly because of the layout style of the text box. HE114 commented that one had to retype all sentences in the box if it was wrong. These comments reflected students' frustration with some of the technical issues with hardware and software. They found drawing and editing text was quite challenging. This is attributed to their limited experience with and knowledge of the software. Students were concerned about the time wasted when they had to wait for other students to complete the stages of tasks before they were requested to move onto the next stage of activities. Student HE104 commented that it took a long time waiting for everyone to finish each section before proceeding.

Although common concerns echoed were with technical issues such as the web cameras freezing, most technical issues were ironed out early during the exam and students were able to complete it.

Questionnaire Scales

Six scales were derived from combining items from the questionnaire (see Table 3.3, Chapter 3). Descriptive statistics for these scales are shown in Table 5.3 and graphs in Figure 5.3, the the results for each scale being discussed separately.

Table 5.3
Descriptive statistics for the student survey scales for the HE class

Scales	HE Class					Population		Sample
	N	Min	Max	Mean	SD	Mean	SD	Effect Size
eAssess	21	2.00	3.64	2.92	0.40	3.16	0.50	-0.48
Apply	21	1.67	3.00	2.23	0.42	2.38	0.38	-0.39
Attitude	21	2.00	3.00	2.60	0.27	2.63	0.32	-0.09
Confidence	21	2.00	3.00	2.75	0.29	2.77	0.29	-0.07
Skills	20	2.09	4.00	3.30	0.56	3.27	0.47	+0.06
SCUse	21	5.00	156	54	43	58	50	-0.09
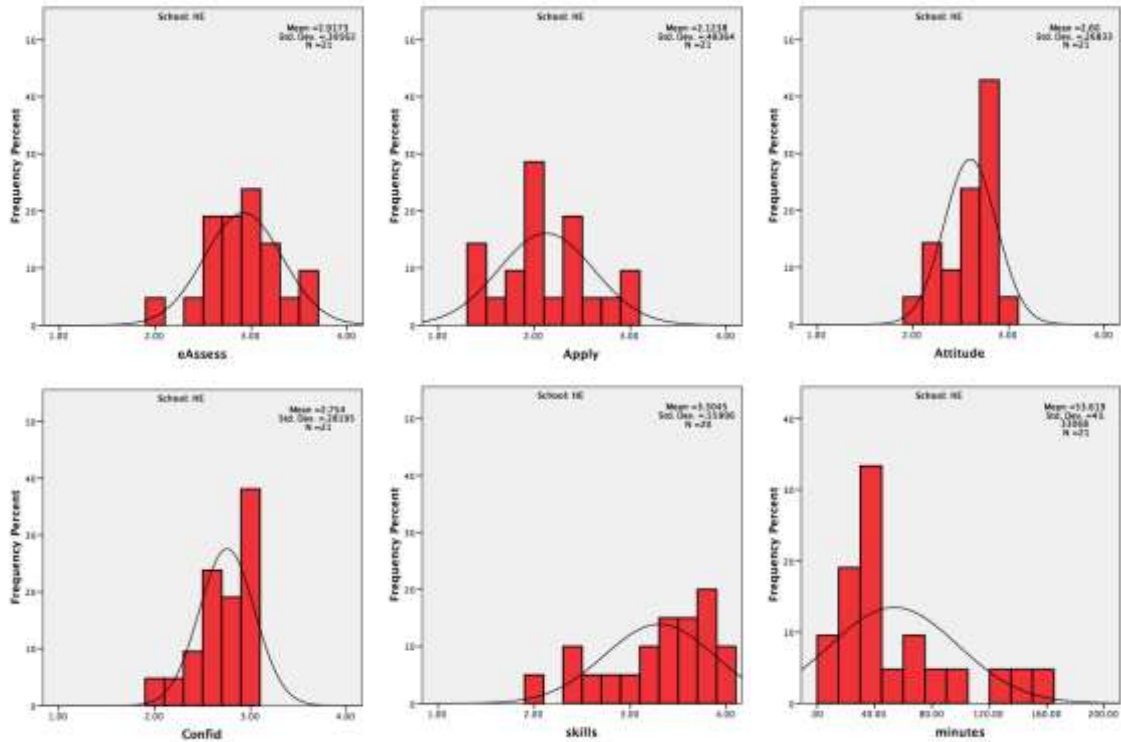
Figure 5.2 Distribution of scores for the student survey scales for the HE class

The eAssess graph showed most students to fit between 2.50 and 3.50 scale with a mean of 2.92, which was half a standard deviation below that of the population mean of 3.16. A standard deviation of 0.40 showed most students were evenly spread between 2.5 and 3.5 with most of them above the midpoint 2.5; this indicated them to be positive about computer-based exams. The effect size of -0.48 indicated their perceptions about the efficacy of using computers for the assessment were less positive than the population. Generally they tended to have positive attitudes and perceptions towards the efficacy of the Engineering exam.

The Apply graph showed a large spread amongst these students with most scoring around the midpoint of 2. The mean for this graph was 2.23, which is slightly below that of the population mean, 2.38. However an effect size of -0.39 showed these students were similar to the population in attitudes and perceptions towards the application of computers

The Attitude graph indicated most students to lie in the range between 2.00 and 3.00, with the graph skewed towards the positive. The mean for Attitude was 2.60, close to the population mean of 2.63. An effect size of -0.09 shows these students was equally positive to that of the population.

The Confidence graph was skewed to the positive with most students scoring above the 2.50 midpoint; the mean was 2.75 and SD 0.29. A larger number of students were on the higher

179

end of the confidence scale; however an effect size of -0.07 indicated them to be as confident as the population about using computers.

The Skills graph was skewed to the positive with most students scoring closer to the midpoint of 3.80, with the mean of 3.30 being slightly above the population mean which indicated a high percentage of them were likely to be more positive towards their ICT skills. However, an effect size of 0.06 indicated that, on average, their high perception of related skills was similar to that of the population.

The SCUse graph was well spread with a mean of 54 and SD of 43 and skewed slightly to the positive. Most students spent approximately 40 minutes per day at school using a computer. A small number of 8 students spending less than 40 minutes per day. The mean and SD were similar to that of the population, the effect size of -0.09 indicating that these students applied a similar the amount of time to the population on using computers at school per week.

HE Engineering students forum

Forum students were gathered and sat in a semi-circle in a classroom. A transcript of their deliberations is included in Appendix D.

Students responded well to the style of the exam and generally preferred it to a theory paper-based exam. More time would have preferred for the modelling section of the task and some frustration were expressed about with the resolution of the camera used to capture images of their sketches.

They were basically happy using the computer in designing their project, believing computer use to design their project was appropriate to the course; they were challenged by some design principles. Some students remarked on computer use to design a project involved creative thinking and was more relevant to the course. They used various computer applications and accessed the Internet for their class tasks, which helped them in this assessment, being accustomed to using computers.

Students felt computer use to be much quicker for an electronic portfolio than using pen and paper. They indicated that the computer use was very different when designing a project observing computers had never been part of practical exams. Throughout the exam students were content, enjoying using the computer for designing their project. Some of them suggested improvements to the program interface and a text editor would enhance functionality in the exam.

Students encountered some technical problems with the audio recording, the webcam and sketching with the mouse. Overall they did not consider these technical problems were of major concern and were happy with the 3-hour assessment time slot.

Pre interview with the HE teacher

The teacher provided feedback by way of an email return to a set of questions prior to his class being involved in the assessment (Appendix G). The following is a summary of his responses to the questions.

The teacher indicated his students used computers for class theory and research purposes. He believed computers could be used to promote authentic assessment in Engineering Studies, and was supportive computer use for exams, tests and experiments. He was keen to use computers, asking specifically for the use of CAD, photo Imaging, logbook data logging, electronic portfolios, programming and report writing with his students. The teacher indicated a preference that his students used computers at least 70% to 80% in class and 20% to 30% in the workshop. He believed they had a better understanding of the learning medium and could become more engaged in the pursuit of knowledge. He would like to see online assessment so that students could complete the exam or test whenever ready. He was extremely positive about using ICT to support assessment. He was a confident user of ICT and had skills in using computers, thus promoting authentic assessment within his learning area. He believed that using computers for assessment reinforced his students' cognitive learning.

Post interview with the HE teacher

The teacher provided feedback by way of an email return to the questionnaire protocol after his class completed the assessment (Appendix J). The following is a summary of responses to the questions.

The teacher commented that the Engineering exam was a success as an assessment, his students responding well to the content and process of the exam. Their feedback on the exam was sound and appropriate. They were able to complete the requirements of the exam being positive and enthusiastic, expressing genuine interest in the task, and indicating much potential for computers in all practical subjects. The teacher was surprised by the performance and attitude of his students, commenting, 'I thought they might be indifferent but they were keen, busy and focused.' His students indicated a liking for more of this type of assessment.

The teacher also suggested a way was possible to develop an e/folio for pair-wise assessment and moderation.

The teacher commented that the exam was implemented successfully with no logistic or technical difficulties. However he observed some students wasting valuable time waiting for everyone to complete the tasks before moving to the next step. He demonstrated a positive attitude and a willingness to support the development of the use of digital forms of assessment, commenting that his students generally preferred more time to familiarise themselves with the equipment for the task at hand so that they could have improved their results. Regarding the modelling section, he believed some students a level of frustration with the resolution of the camera when capturing images of their sketches.

CBAM analysis

The results of the data analysis concerning this teacher were used to make judgements about the three constructs employed as a diagnostic tool for analysing the implementation of digital forms of assessment in the Concerns Based Adoption Model CBAM:- Innovation Configuration (IC); Stages of Concern (SoC); and Levels of Use (LoU) that were the outcomes of these judgements along with summaries of the evidence supporting them are provided in Table 5.4. The numbers in the judgement column are from the CBAM Innovation Configuration in Appendix A.

Table 5.4
Judgements for the HE teacher on the CBAM Constructs

Construct	Judgement	Evidence
IC Access to ICT to support Assessment.	(1) Teacher has access to ICT for assessment at all times.	Teacher delivered the Engineering course in a computer lab. He had access to the Intranet and Internet and used online exam or tests, but gave no evidence of using ICT for assessments.
Digital Forms of Assessment.	(3) Teacher may use one form of DFA.	Teacher used online exam, tests and computer simulations for some forms of assessments.
ICT and Pedagogy.	(2) Teacher uses ICT for some learning activities.	Teacher used the Internet and Intranet for most teaching and learning activities with CAD, Photo Imaging, Logbook data logging, Electronic portfolios, Programming and Report writing with his students.
SoC	(3) Management.	Teacher shared some exploration with the use ICT with another Engineering teacher in this school and they supported using computers for exams.
LoU	(3) Mechanical.	Teacher had only used online tests, although he was keen in supporting ICT use, but had not actually used ICT much in assessment in his course. However overall he supported the implementation of the exam for the project.

Conclusions about the attitudes and perceptions of the HE Teacher

In this section the discussion is centred on the summary of CBAM judgements about the set of attitudes and perceptions of the HE Teacher.

Attitudes and Perceptions towards using ICT to support assessment

The teacher was able to access ICT for assessment at all times and used online tests to reinforce learning. Although he was aware of the need for ICT to support assessment, he had not done so in his course. He was very supportive and showed a positive attitude towards the use of ICT for this assessment.

Attitudes and Perceptions towards ICT, pedagogy and the course

The teacher believed that digital forms for assessment reinforced cognitive learning for his students, and it was closely aligned with the Engineering Studies. He felt that students tended to have an affinity for ICT and seemed to be relatively more visually engaged with digital forms. He had used the Internet for graphical simulations in the course, feeling the students were able to relate to the course work well as it related to a more interactive learning environment. Further considered ICT to have an appropriate pedagogy for the delivery of the

Engineering Studies curriculum and outcomes which would more meaningful because of ICT support.

Attitudes and Perceptions towards ICT supporting the Engineering exam

The teacher felt the modelling section of the exam needed some refinement because some students felt frustrated with the camera's resolution when capturing images of their sketches. Overall he believed the exam was appropriate with ICT support and students generally were more engaged and enjoyed the exam. He thought this exam format would be appropriate across other subject areas in the school; he was highly positive towards the way the exam was implemented.

Conclusions about the attitudes and perceptions of the HE Students

The discussion herewith concerns a summary of the results from the survey and the student forum regarding student attitudes and perceptions.

Attitudes and Perceptions towards using ICT

The students were generally confident in using ICT, indicating they were happy using computers to solve new problems. They used ICT on a daily basis for learning and keeping in touch with their peers, so accessing and using ICT was part of their interaction with their environment. They were comfortable and had strongly positive perceptions of their skills with ICT.

Attitudes and Perceptions towards ICT and learning and the course

The students confessed they lacked ICT skills in some software applications when they put their design ideas together on their computers. This could be attributed to the unfamiliarity of applying the software. Some students' reflected on needing more time to become familiar with specialised software applications such as web authoring, video editing and drawing. This indicated that, although they lacked some ICT skills for assessment, they were willing to spend a little more time in overcoming this thereby indicating positive attitudes and perceptions about embracing ICT for learning. The students thought using the computer to design their project was appropriate to the Engineering course. They enjoyed the 'hands-on' approach to a practical course and would prefer this form of assessment to a paper-based form currently used.

Attitudes and Perceptions towards ICT supporting the Engineering exam

Basically the students were happy deploying when designing their project in the Engineering Studies exam. Most indicated they had completed a design project on a computer before the exam and were familiar with this process. They found the exam to be easy, completing it comfortably within the allotted three-hour period. Some students indicated would like to see all Engineering exams to be in this format; they would welcome the change.

Some students realised they lacked skills in some software applications when they completed their design ideas on the computer. This could be attributed on the unfamiliarity of using the application software. Some students required more time to get used to specialised software applications such as web authoring, video editing and drawing. The skills required in the application of the webcam for related activities in the exam, which required students to take pictures of their sketches throughout their design brief, could contribute to these students having less positive perceptions and attitudes to the exam.

Overall, results from the student survey showed most students had a strongly positive attitude towards the Engineering Studies exam and had embraced the value of ICT to support the exam.

Case Study LE: Public School

The LE case study involved one class of thirteen Year 11 students completing the Engineering Studies course Unit 2B. They were to redesign the Hexapod articulated robot (AR) so as to control remotely as it negotiated a set obstacle course. The teacher prepared a booklet setting out the design guidelines for this task.

Implementation, Technologies and Issues Arising

This school had a regular relationship with ECU where the Year 11 Engineering Studies students performed their class work for 3 hours each week with the Design and Technology program or 3rd year teacher trainees. It was therefore decided to conduct the assessment task at the university rather than the school. One laboratory on the ECU campus was requisitioned for the students to complete the exam. The room consisted of computer workstations around the wall with large tables in the middle of the room; this was ideal organisationally for this examination as the students could do the model construction activities on the central table. No photo of the room was taken for presentaion in this study.

Access to the web server, which housed the examination, was difficult at ECU due to IT firewalls in place. It was decided to setup one of the computer labs on campus especially for this exam to cater for these students. Thus the form of e-Scape system employed was linked 'live' to the Internet.

Results from data analysis

A range of data was collected and analysed, including observation of the class, an interview with a group of students, an interview with the teacher, and a survey of the students. The results of analysis of each of these sources of data, for this case study are discussed separately. At the completion of this section a summary based on all sources of data is provided by a CBAM analysis and conclusions.

Observations of the class

Members of the research team visited the class conduct the assessment task and collect the qualitative data. Students in this group accessed the relevant ECU labs and logged on to the online e-Scape system to access the exam. The research facilitator was also logged on as the

186

examination manager thereby being able to monitor each student's progress throughout the examination tasks and stop or extend a task if necessary.

No important implementation difficulties occurred, but during the exam minor technical problems arose with the use of the webcams, wherein minor adjustments to the focusing of the aperture setting in order to obtain a clearer image were needed. A small number of computers needed re-booting at the initial logon stage. The timing of individual activities caused some concern for students who were able to complete their activities inside the time; they to wait for the others slower before moving onto the next activity. The students accepted these minor delays and the exam proceeded well for these students .

Survey of Students

Twelve students completed the closed and open response items in the survey. The results of analysis each item are discussed in this section. A summary of descriptive statistical results for the closed items appears as Appendix H.

Closed Items

For item E1a most students confessed to having completed design projects employing computer applications previously; however, two students (LE109 and LE112), indicated they had completed many. Two other students (LE110 and LE111) indicated no need for additional time to become familiar with designing a project using a computer. The mean for QE1a was slightly below the population mean. Item effect sizes were between absolute values of 0.2 and 0.3, indicating these students were not significantly different to that of the population.

For E2 items, four students were a less positive about the value of using computers for the Engineering assessment. The item means were slightly below that of the population mean. However item mean difference effect sizes had absolute values between were 0.0 and 0.2 which points out that the perceptions of these students concerning the efficacy of using computers for the assessment were not less positive than the population.

For Q5 items, two students, (LE110 and LE112), noted they used the full range of devices listed, apart from the webcam. One student (LE102) indicated he only used MP3 player and a game console at home. Most students revealed they did not use a video camera, a webcam and a mobile phone. Item mean difference effect sizes were between absolute values of 0.2 and 0.6, indicating these students to be similar to the population with the various uses of computer technologies at home.

187

For Q6, all students in this study cohort agreed they had access to Broadband Internet at home. The mean was relatively similar to the population, conveying they were no different to the population in the matter of access to Broadband Internet.

For Q7, nine students (LE101, LE103, LE104, LE105, LE107, LE108, LE109, LE110 and LE112) affirmed they used a computer at home most days. Three students (LE102, LE106 and LE111 declared they used a computer more than once a week at home. Effect size of 0.0 agreed these students to be similar to the population about the frequency of computer usage at home.

For Q8, students spent an average of 55 minutes each day using computers at school. Item effect sizes were between absolute values of 0.0 and 0.3, which indicated they were different in the amount of time spent on computers in a week than that of the population.

For Q9, most students purported to touch-type with all their fingers, with the exceptions of three students (LE101, LE109 and LE110). More students in this class indicated they touch-typed; however there were relatively no differences to that of the population for ths question.

For Q10 items, students' responses were generally positive about computer deployment for the range of tasks listed, except for Q10a, keeping addresses, and seven students (LE102, LE104, 106, LE108, LE110, LE111 and LE112) revealing they did not keep a list of addresses of friends. Likewise for Q10b, drawing a diagram for six students (LE101, LE102, LE105, LE106, LE108 and LE109) proved to be difficult as they could not draw a diagram or picture using a computer. The mean was slightly below that of the population; however, the item effect sizes were between absolute values of 0.0 and 0.4, this pointing to most students being similar to the population concerning their range of computer applications.

For Q11 items, students were generally positive with the exception of exception of one student (LE106) who was negative about computers being good for the world. Nine students believed computers were good for the world. Generally students confessed to a liking for discovering matters of knowledge for themselves rather than being told by the teacher. Item effect sizes were between absolute values 0.2 and 0.3, signifying these students being similar to population views about their perceptions of, and attitude towards the value of using computers at school and at home.

For Q12 items, students in general denoted they were confident and competent with computer usage. All students, with the exception of one declared they could learn to program a

computer (Q12e). They all affirmed it was easy to employ a computer (Q12f). Ten students (LE101, LE102, LE103, LE104, LE107, LE108, LE109, LE110, LE111 and LE112) indicated they were happy to solve a new problem using a computer (Q12c). All students asserted that they usually do well with computers (Q12d). One student (LE106) confessed he could not learn to program a computer (Q12e). Item effect sizes were between absolute values of 0.2 and 0.4, which pointed out that these students were similar to the population concerning confidence in working with computers.

For Q13 items most of the students in this class indicated that they could do most of these listed from Word processing to video editing. Three students out of twelve intimated they could not understand Webpage authoring. Most students in this class declared they had a high level of skills in computer file management (Q13f) and the Internet (Q13g). However, four students (LE102, LE106, LE107 and LE108) who indicated lower levels of skills for databases, webpage authoring, digital photography and video editing (Q13c, h, i and k). Item effect sizes of absolute values around 0.0 to 0.4 told that these students were not significantly different to that of the population in their self-assessment of computer software application skills.

Open-ended items

Students responded to two open response items asking to notify the two best and worst things about doing the exam. A summary is given in Appendix L.

For the two best things most students considered typing on the computer was easier than writing and it was quicker. Most students with three exceptions (LE101, LE106 and LE107) revealed they did not touch type using all fingers. Students who touch typed commented that it was quicker to type than to write. Two students (LE101 and LE108) conveyed typing was more legible than their handwriting. Student LE109 forecast that doing the Engineering exam using computers was the way of the future. Generally students considered typing using computers in the exam was easier than writing.

For the two worst things about doing the examination by computer comments from this class were mainly concerned with mal-functions, slowness and freezing of the computers. Student LE108 declared this exam was the first occasion during which he had completed an exam using a computer; he was not prepared for computer application. One student (LE101) commented on difficulty for him to draw pictures using a mouse on a computer. All these

comments reflected the students' frustration of some technical issues with hardware and software. The webcam and audio recording tool were the least used tools in their school curriculum. These attitudes could be attributed to their limited experience and knowledge with the webcam and audio recording process. They found that drawing and editing text was quite challenging in some sections of their examination, an oucome of their limited exposure to such computer application tools.

Two students (LE102 and LE109) were concerned about the time wasted as they waited for slower students to complete the mandated stages before moving to the next stage of activities. One (LE104) pointed to the insufficient time allocated for the exam. These issues could be attributed to some students' unfamiliarity with the software and hardware used in the exam. Most technical issues were repaired early on in the exam and students were able to complete the exam.

Questionnaire Scales

Six scales were derived from combining items from the questionnaire (see Table 3.3, Chapter 3,). Descriptive statistics for these scales are depicted in Table 5.5 and graphs in Figure 5.4. The results for each scale are discussed separately.

Table 5.5
Descriptive statistics for the student survey scales for the LE class

Scales	LE Class					Population		Sample
	N	Min	Max	Mean	SD	Mean	SD	Effect Size
eAssess	12	2.18	3.82	3.23	0.46	3.16	0.50	0.16
Apply	12	2.00	3.00	2.31	0.26	2.38	0.38	-0.18
Attitude	12	2.20	3.00	2.68	0.23	2.63	0.32	0.16
Confidence	12	2.50	3.00	2.87	0.17	2.77	0.29	0.34
Skills	12	2.45	4.00	3.38	0.49	3.27	0.47	0.23
SCUse	12	0	210	55	58	58	50	-0.06
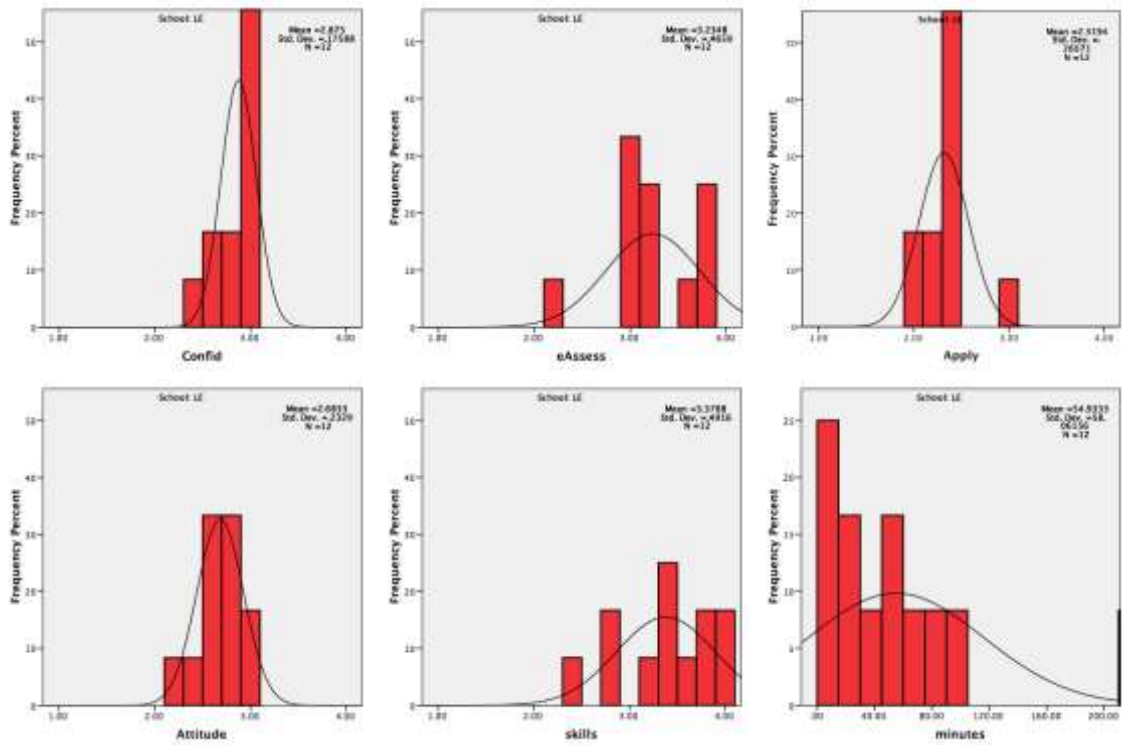
Figure 5.3 Distribution of scores for the student survey scales for the LE class

The eAssess graph depicts most students scoring between 3.00 and 4.00 with a mean of 3.23 and a standard deviation of 0.46. The mean was slightly above the population mean. The graph was skewed positively, most students having indicated no need for more time to be familiar with the computer when completing design projects. An effect size of 0.16 signified this cohort of research students was as positive as the population about entering upon the Engineering exam.

The Apply graph showed most students were measured between 2.00 and 2.50 with a class mean of 2.31; this is slightly lower, than the population mean of 2.38 with a standard deviation of 0.26. This denoted the spread of these students was less across the range, more of them being concentrated in the 2.50 range. An effect size of -0.18 inferred that these students were similar to that of the population with regard to their use of computer applications.

The Attitude graph was skewed positively, having a mean of 2.68 and a standard deviation of 0.23, being one SD below that of the population of 0.32. More students clustered closely in the mid-range scale. However an effect size of 0.16 indicated this group of students was as positive in their attitudes and perceptions towards using computers for learning as the population.

191

The Confidence graph was skewed positively with a mean of 2.87 and SD of 0.17. Most students were grouped between the range 2.50 and 3.00. A little less spread compared to the population was apparent, with more of them affirming their confidence in using computers. However, an effect size of 0.34 indicated they were at least as confident as the population.

The Skills graph was skewed positively having a mean of 3.38 and SD 0.49. Most students' scores were towards the higher end of the graph depicting a high percentage of students were positive about their ICT skills. However an effect size of 0.23 showed their perceptions and those of the population were similar.

The SCUse graph was skewed negatively with a mean of 55 mins and SD 58 mins. A small number of students who spent less time using a computer at school than the population. Two students respondents declared they did not use a computer at school. Most students affirmed their use of a computer somewhat less on Mondays and Fridays. However, an effect size of -0.06 they were similar to the population regarding time per day spent using computers.

LE Engineering students forum

FGor the the forum students gathered around a bench in the ECU lab for their discussion. A transcript is included in Appendix D.

Generally students were happy with the exam; however some were concerned and felt frustrated with the lack of time allocated to the exam. Other students were concerned with the quality of the webcam, preferring more time for the modelling section. They thought not enough information and choice were available about the type of materials to be utilised for the design of the project. Some commented on their capability with computers helped them and allowed them to provide their best quality of work. They affirmed computer use in designing their project was very different requiring new skills. The cohort observed that computers had never been used in a practical exam in their course; thus it was exciting for them, especially for the assessment tasks. Suggestions for improvement included an improved interface and the text editor in the software, less restriction on some software application, a bigger screen and an increase of time for the exam.

Pre interview with the LE teacher

The teacher provided feedback by way of an email return to a set of questions prior to his class being involved in the assessment (Appendix G). The following is a summary of responses to the questions.

The teacher indicated his students had used computers for theory and research assignments. He believed computers could be used to promote authentic assessment such as exams, tests and experiments indicating a variety of software programs could be employed such as programming and CAD in the class. His preference was for computers to be used at least 50% in class and 30% in the workshop. One of the strengths of using computers for assessment he claimed was the ability to capture student's work in real time and provide timely feedback. This was essential for students when they were undertaking research assignments wherein online assessment would ascertain would complete sections of their at the exam or test whenever they were ready. He was extremely positive about using ICT to support assessment.

Post interview with the LE teacher

The teacher provided feedback by way of an email return to a set of questions (Appendix J). The following is a summary of responses to the questions.

He commented positively saying the overall assessment tasks were good; however, some tasks were too broad and general. He felt students could have performed better if given more time to familiarise themselves with the equipment before the assessment task. He considered the timing and the flow of activities was satisfactory. Students completed the requirements of the exam in the 3-hour time frame, responding well to the activities the instructions for which were succinct and instructive. His students' feedback signified the assessment was sound and appropriate, a method of exam they preferred. It captured actual performance as opposed to text-based exam and having potential to be a fairer representation of students' abilities. He summed up saying the quality of students' work in the assessment was good, the students were positive and enthusiastic expressing genuine interest in the task, and demonstrating its utility for all practical subjects. His final comment indicated he was pleased by the performance and attitude of his students.

The teacher affirmed the assessment task was implemented successfully with no logistical or technical difficulties, and all students being able to complete the requirements of the exam. He had a positive attitude and a willingness to support the developing the use of digital forms of assessment, commenting his students would happily complete this type of assessment again.

CBAM analysis

The results of the analysis of data from the previous sections were employed making judgements for the three constructs of the CBAM:- Innovation Configuration (IC); Stages of Concern (SoC); and Levels of Use (LoU); these had been employed as diagnostic tools for analysing the implementation of digital forms of assessment with this student cohort. The outcomes of these judgements together with summaries of the evidence supporting were tabulated (see Table 5.6). The numbers in the judgement column record the CBAM Innovation Configuration (Appendix A).

Table 5.6
Judgments for the LE teacher on the CBAM Constructs

Construct	Judgement	Evidence
IC		
Access to ICT to support Assessment	(1) Teacher had access to ICT for assessment at all times.	Teacher had access to ICT and Internet and used some forms assessment. Although he was a keen supporter and highlighted the value of ICT supported assessments, he was in the early stages attempting to use ICT to support assessment in Engineering.
Digital Forms of Assessment	(3) Teacher used no alternative ICT assessments with his course.	Teacher used program simulations for testing robotics movement or to program the functionality of the Hexapod articulated robot. This may have some digital forms relevance to DFA, but was not applied to this course assessment of student work.
ICT and Pedagogy	(2) Teacher used ICT for some learning activities.	Teacher had used a variety of software programs such as report writing, CAD with his students. He used ICT in designing a 'remote' control system for a Robotic project as part of the Engineering course.
SoC	(2) Personal	Teacher used Robotics Programming as one of the ICT focus in the Engineering course, but not for assessment.
LoU	(3) Mechanical	Teacher integrated Robotics into his curriculum. He shared his skills in teaching Robotics with some colleagues. Perhaps early attempts to explore ICT for assessment. Overall he had just implemented the exam for the project for this study.

Conclusions about the attitudes and perceptions of LE Teacher

This discussion is centred on the summary of CBAM judgements in about attitudes and perceptions of the teacher.

Attitudes and Perceptions towards using ICT to support assessment

The teacher was very supportive and extremely positive towards accessing ICT for assessments. He believed students should have a better understanding of using ICT as a

194

medium, and being more engaged in the pursuit knowledge. He would prefer online assessments so that they could be utilised whenever appropriate. He had a positive attitude towards digital forms of assessments and was highly likely to support this form for the Engineering Studies course. The teacher believed that by capturing actual performance as opposed to text-based exam had more potential to being a fairer representation of students' abilities.

Attitudes and Perceptions towards ICT, pedagogy and the course

The teacher had used a variety of digital forms of simulation programs for testing robotics movements for learning activities in the course; he believed these had relevance for performance-based courses. He was a confident user of ICT, considering the nature and knowledge of learning were related to attitudes and perceptions about relevant pedagogical practices. He perceived an ICT rich learning environment could be more visual in presenting practical components of the course.

The teacher would prefer more online topics for the Engineering Studies course. He encouraged his students to use ICT by focusing on and setting tasks rich in ICT content in the course.

Attitudes and Perceptions towards ICT supporting the Engineering exam

The teacher believed his students responded well to the activities in the exam. He expected this feeling ICT supported the Engineering exam and was well accepted by his students.

Conclusions about the attitudes and perceptions of LE Students

The discussion herewith centres on the summary of results from the student survey and forum discussion about the attitudes and perceptions of LE students.

Attitudes and Perceptions towards using ICT

Most these students used some ICT devices for between 30 to 240 minutes a week. They were all competent at social networking on the Internet, many belonging to online lists. Most communicated by ICT in one form or another. It can be concluded that, on average, this cohort of students were confident, skilled and experienced with ICT. They kept up with current ICT developments, were passionate about learning with ICT, and sharing with peers. This was an indication of a highly positive attitude towards using ICT.

Attitudes and Perceptions towards ICT and learning in the course

These students were all ICT savvy, accepting its use for learning and accepting the challenges of learning with ICT. They appreciated its value in the learning process, commenting they could discover new knowledge without being given information by the teacher. Often learning with ICT a sense of exploration was a motivating factor for further learning. They had grown up with ICT and had a highly positive attitude towards the efficacy of ICT for learning. Most of these LE students displayed a positive attitude towards ICT in the Engineering Studies course; they were confident with ICT, discovering answers for themselves. Their use of ICT daily twas similarly perceived by the population.

Attitudes and Perceptions towards ICT supporting the Engineering exam

LE students believed ICT support of the Engineering exam was appropriate. By deploying the computer to design their project closely reflected practical tasks. Their ICT use supporting the exam enabled more realism in designing the project; thus they thought they did their best quality work. However some students were concerned with the quality of the images captured with webcam because of its low resolution. They would prefer more time for the modelling section of the task. They also realised not enough information was provided and limited choice given to the type of materials for use in the design of the project. On the whole, these students were positive in the recording of their design and modelling, hence enjoying more this format compared to a paper-based format.

Case Study RE: Public School

The RE case study involved one class of 16 Year 11 students completing the Engineering Studies course Units 2A-2B. Fourteen participated in this assessment task in which they were to to design a power bike light and completing a series of system control activities.

Implementation, Technologies and Issues Arising

The school's curriculum computer network system was configured with highly restrictive levels of security access for students. Students' logon accounts were mostly protected with firewall settings and students' logon scripts, and limited access to the school curriculum server. Many Internet sites were blocked; therefore this was not an environment suitable for students doing the exam online. They were required to upload files to the e-Scape examination server. The form of e-Scape system used at this school was difficult to access but

this was overcome by employing Intranet via a laptop computer server and a wireless router. All the students were issued with ASUS EeePC netbook computers which were wirelessly linked with the research facilitator's laptop computer. The room selected was a computer room (see Figure 5.5), which had computers on tables in a range of configurations around the room. Some of the desktop computers were moved to allow workspace for the students with netbooks to complete the exam. The battery on these computers lasts for about 3 hours; thus because of the length of the task, this impediment, power cables were used. An external web camera and mouse accompanied each netbook.

Results from data analysis

A range of data was collected and analysed, including observation of the classes, an interview with a group of students, an interview with the teacher, and a survey of the students. The results of analysis from each of these data sources in this case study will be discussed separately, with finally, a summary based on all sources of data being provided as a CBAM analysis.

Observations of the class

First visit: testing modes for delivering the assessment task (Internet/Intranet)

Members of the research team visited the class, conducted the assessment and collected qualitative data. This first visit was to formalise student consent and obtain information about teacher programs and time tabling. Some setting up and the testing was completed with the school computers to ascetain whether the assessment task would run on these computers. It was decided that the best approach was to use the netbooks via Wi-Fi technology to set up a local Intranet.

Second visit: examination and student survey

On the second visit, students completed the Engineering exam, working on the netbooks provided, and logging on to the local Intranet which acted as the examination server. The facilitator was able to monitor each logged-in student's progress throughout the examination tasks and stop or extend a task if necessary. The setup for this room was not ideal as it was a little cramped, particularly when it came to the modelling aspect of the task (Figure 5.5).

Figure 4.4 A photo of part of the RE computer room

There were initial setting-up problems with the location of power points around the wall in the room needing long extension cords. All students were paired for their critique of each other's sketches; this did not give rise to any implementation difficulties. However, during the exam minor technical problems occurred with the use of the webcam requiring minor adjustment to the focusing of the aperture setting in order to obtain a clearer image. The timing of individual activities caused some concern for students who completed their activities quicker, and had to wait for the others to catch up before moving on to the next activity.

A small number of netbooks needed re-booting a couple of times at the initial logon stage to connect. On a few occasions the 3-pin plugs came loose and the loss of constant power supply to some of these netbooks was undetected until they auto-switched off; this was rectified earlier in the exam. The students accepted these minor difficulties with grace so the exam proceeded well.

Survey of Students

Fourteen students completed the closed and open response items in the survey. Their responses to these items are discussed in this section and a summary the descriptive statistics for the closed items is listed in Appendix H.

Closed Items

For item E1a most students indicated they were already familiar with computerised design project work. However, six students (RE101, RE103, RE108, RE109, RE111 and RE114) who pointed to their not having experienced any design projects on a computer. For E1b two

students (RE108 and RE111) confessed they needed much time to become familiar, but most students agreed they needed little time. Although the cohort's mean for E1a was slightly higher than that of the population mean the indication inferred was they were likely more experienced in completing design projects on computers. Item absolute effect sizes (a and b) were around 0.1 and 0.7, which indicated these students to be similar in experience using the computer for designing projects to that of the population.

For E2 items, most students agreed with the ease of completing the Engineering design project when the computer applications facilitatated this process. Generally students considered it to be easy and fun, the computer assisting them to develop their ideas so they were able to show their best quality work. Students RE109 and 112 provided negative responses to E2(a, b, c, f, i , k). The means for most E2 items were above the population mean, but absolute effect sizes were from 0.0 and 0.6, showing these students were generally a little less positive about the efficacy of doing the Engineering exam using computers compared with the population.

For Q5 items, two students (RE109 and RE111) agreed they used the full range of the devices listed in Q5. Most students however used an mp3 player, laptop computer, game console, mobile phone or a computer. The least used device by these students was the webcam. Item absolute effect sizes were between 0.0 and 0.2, showing these students to be similar in experience to that of the population in the types of devices used at home.

For Q6 all students, revealed they had access to Broadband Internet at home, except for student RE114 who told he used dial-up Internet. However using dial-up Internet did not constrain student RE114's ability to access the full range of computer technology at home.

For Q7 13 students, declared they used a computer most days at home. One student RE101 did not respond to this question. This research group was similar to the population concerning time spent on using a computer at home.

For Q8, these students indicated spending on average around 70 minutes a day using computers at school, which was slightly more than the population average. Absolute effect sizes 0.0 and 0.4 affirmed these students to be similar to that of the population regarding average time spent on computer usage per day in a week.

For Q9, eight students revealed they touch typed using all fingers, three said that they did not touch type at all, and three gave no response. Their average effect sizes were similar to the population norm.

For Q10 items most students' responses were positive. However, one student, RE112, admitted not using a computer to type an assignment for school, and two students (RE104 and RE114) conveyed no computer use in completing a line graph or pie-diagram as part of an assignment. Most students agreed they used all the applications listed in Q10 items. Item effect sizes of absolute values were between 0.0 and 0.5, indicated they difffered marginally from the population in the application of various technologies listed in Q10.

For Q11 items, two students (RE101 and RE114) noted explicitly that using computers made the work at school more difficult. Student RE101 said he did not enjoy using computers at school (Q11b). However, six of the14 students in the cohort agreed that sometimes they liked to use a computer at home to do school work. The class means for Q11(a, b , c) were above the population means but item absolute effect sizes 0.0 and 0.2 showed them as likely to have a positive attitude; in that and they were similar to the population.

For Q12 items, students indicated confidence generally in using computers. However three students (RE107, RE109 and RE114) confessed not being confident about learning to program a computer (Q12e). Similarly for Q12d, two students (RE107 and RE109) declared not being uncertainty about doing well with computer applications and one student RE114 affirming he did not do well with computers. Item absolute effect sizes between 0.1 and 0.5, proved these students were similar in confidence to that of the population in using computers.

Q13 items indicated most students in this cohort to have a high level of skill in using most of the software listed, in particular email and Internet applications (Q13e and g). Student RE112 was the only respondent to confess not to be competent in word processing and video editing (Q13a and k). Student RE107 admitted he couldn't print a document, change fonts, spell check and insert a footer and page numbers (Q13a). Student RE112 likewise agreed he couldn't enter data, use sort, create charts/graphs and modify them (Q13b). In general students in this class appeared to be less skilled with Databases, Webpage authoring and Video editing (Q13 c, h and k). However, the group's absolute item effect sizes were between 0.0 and 0.5, indicating very little deviation from the mean of these students' self-assessments of ICT skills compared to that of the population.

Open-ended Items

Students responded to two open response items seeking their answers to the two best and worst things about the exam. A summary of responses is given below to the questionnaire which appears in Appendix I.

For the two best things, most students considered the ease of undertaking the assessment using a computer the most enjoyable. Six students preferred to type rather than to write and to read typed text than handwritten text was easier (RE.101, RE102, RE105, RE109, RE112 and RE114). Two students (RE107 and RE113) thought typing was quicker than handwriting. While student RE114 thought completing the exam using computers was like a 'real-life' setting. Generally students considered the application of computers in the exam was easier and quicker than using a pen in doing the design project.

For the two worst things about completing the examination by computer, most students in this class expressed unhappiness with waiting for others to complete a task before they were allowed to proceed to the next step of the assessment. The other major concern with this form of assessment concerned the range of technical issues, such as, computers lagging, computers freezing and the capability of the webcams. However, they were generally happy and comfortable with the assessment process. All these negative comments reflected students' frustration with technical issues of hardware. Some of these issues could be attributed to a few students' unfamiliarity with hardware used in the exam, in particular, the recording or capturing of their design process using the various functions of the webcam. Most technical issues were overcome early during the exam with students being able to complete the 3-hour exam.

Questionnaire Scales

Six scales were derived from combining items from the questionnaire see Table 3.3, Chapter 3). Descriptive statistics for these scales are depicted in Table 5.7 and graphs in Figure 5.5, the results for each case being discussed separately.

Table 5.7
Descriptive statistics for the student survey scales for the RE class

| Scales	RE Class					Population		Sample
	N	Min	Max	Mean	SD	Mean	SD	Effect Size
eAssess	14	2.18	3.55	2.97	0.40	3.16	0.50	-0.38
Apply	14	1.67	3.00	2.50	0.40	2.38	0.38	+0.31
Attitude	14	1.80	3.00	2.60	0.40	2.63	0.32	-0.09
Confidence	14	2.00	3.00	2.70	0.30	2.77	0.29	-0.24
Skills	14	2.36	3.73	3.19	0.47	3.27	0.47	-0.11
SCUse	14	0.00	180	69	48	58	50	+0.23
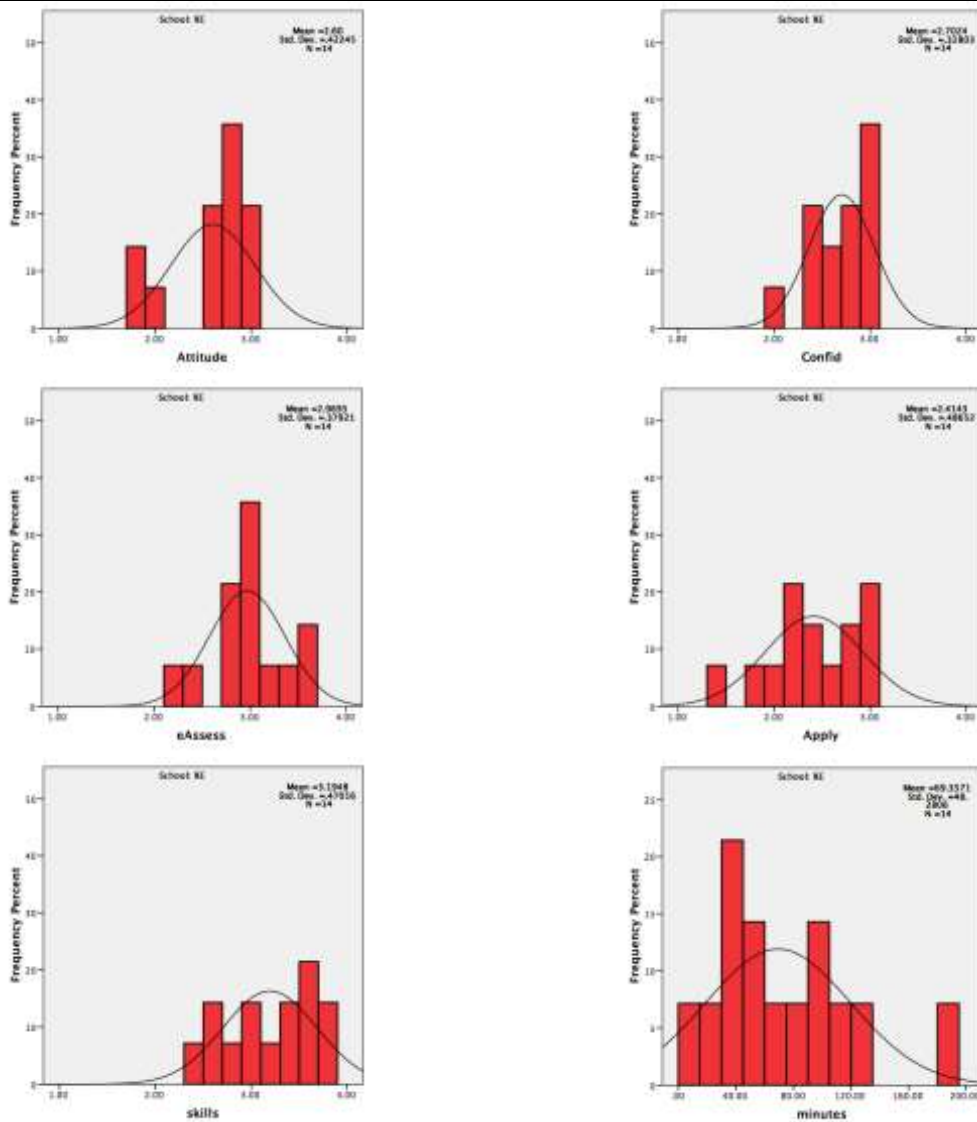
Figure 5.5 Distribution of scores for the student survey scales for the RE class

The eAssess graph showed that most students fitted between 2.50 and 3.50 on the scale, with a mean of 2.97 and a standard deviation of 0.40; it was skewed positively. The mean for eAssess was below the population mean with a smaller SD. However, an effect size of -0.38 this cohort was not significantly different to that of the population in attitudes and perceptions towards the efficacy of a computer-based exam.

The Apply graph revealed a good spread amongst the students in this group, with a slightly longer tail ranging between 1.00 and 1.50. The class mean of 2.50 with a standard deviation of 0.40 indicated that more students in this class were as likely as the population to use the computer applications. An effect size of +0.31 demonstrated this class average to be similar to that of the population.

The Attitude graph was skewed positively with most students ranging between 2.50 and 3.00. The class mean of 2.60 was close to that of the population mean of 2.63, and an effect size of 0.09 indicating this class was similar to the population in having a positive attitude towards using computers.

The Confidence graph was skewed positively with a mean of 2.70 and, SD 0.30 which showed these research students were generally confident in using computers. An effect size of -0.24 supported their being as the population.

The Skills graph was positively skewed to the positive with the study group mean of 3.19 and SD 0.47; this revealed an equally spread distribution. The group mean was slightly lower than that of the population, but an effect size of -0.11 represented them as being average and similar to the population in their perceptions of the skills being investigated.

The SCUse graph was skewed negatively the class mean being 69, above the population mean of 58, with a standard deviation of 48. This indicated a slightly more students in this class spent relatively more time using computers in a week. An effect size of +0.23 implied they spent a similar amount of time per day at school using computers as the population.

RE Engineering Students Forum

For the forum RE students were gathered around a workbench in the lab. A transcript of the forum's discussion is included in Appendix D.

Generally students were happy with exam but some were concerned feeling frustrated with technical issues, quality of the webcam, and lost power supply to the mini computers when the power point came off the outlet socket. They would prefer not having to wait for all

students to complete a task before being allowed to move on to the next task. Some found that the wording of some of the tasks too vague. They discerned their work had improved because the computers were an important aid to them. All agreed this exam to be very different to those previous because utilising the computer to design their project was very different, requiring new skills. Some of the suggested included: having the use a full size keyboard with the netbooks; and better quality webcams. A number of students suggested this exam to reflectthe reality of a course with practical components, and such forms of assessment should be applied to future assessments in engineering courses. Overall the students completed the exam in the allocated 3 hours.

Pre interview with the RE teacher

The RE teacher provided feedback by way of an emailed answers to a set of questions prior to her class being involved in the assessment (Appendix G). The following is a summary of responses to the questions.

The teacher reported her students used their computers for class theory, research and printing their work. She employed computers specifically for research assessment wherein students had to come up with definitions and subsequent follow up work. She produced computerised worksheets of circuit diagrams for them feeling it was necessary to engage the students in computers in order to highlight the value of digital forms of assessments. She preferred her students to have access to computers for approximately 70% to 80% of the time alotted to the Engineering Studies course. She contended computers could be used to promote authentic assessment such as exams, tests and experiments because she used a variety of computer programs such as Drawing, Paint and CAD in her class. Thus one of the strengths of using computers for assessment was the management and storage of students' data in digital portfolios, providing greater security and the safe keeping of student's data/information and providing much faster access from one central location. Students could then do the exam or test whenever they were ready. She considered it challenging to discourage plagiarism of students' work. Although she admitted there to be room for improvement for employing computer technology with digital forms of assessment, she felt positive about and willing to embrace computer assessment in her class.

Post interview with the RE teacher

The teacher provided feedback by way of an email return to a set of questions after her class completed the assessment (Appendix J). The following is a summary of her responses to the questionnaire.

The teacher commented that the assessment tasks were good, valuable and the exercise was a valuable experience for her and her students. She indicated the structure of the activities to be good; however the instructions and the timing of the flow of the tasks should have been displayed on the board so that students could read and follow them. In general, the timing was satisfactory and the flow of activities went well. Most students were surprised this assessment was an exam, but enjoying the model making and the use of the web cam. The teacher believed her students' work to be mostly very satisfactory considering their limited choice of materials. Students were generally on task and their feedback was that the exercise was 'cool' and 'fun', and they would like more time for designing the models. She named some of the minor problem that had occurred. Technical problems did occur with some of power connections and the power boards under the tables, the netbooks losing their main power supply, and the batteries in the netbooks becoming flat. The need arose to keep students focused, in particular those who had completed a task earlier and needed to move on to the next. A timer should be displayed around the room visible to all students, as an aid to their timing of each task. This RE teacher indicated that she was open to the idea of digital forms of assessment, concluding she was keen to see this form of assessment taken up by the Design and Technology department in her school.

CBAM analysis

The results of the analysis of data aggregated in the previous sections were used to make judgements for the three constructs of the CBAM:- Innovation Configuration (IC); Stages of Concern (SoC); and Levels of Use (LoU) employed as diagnostic tools for analysing the implementation of digital forms of assessment for this teacher. The outcomes of these judgements with summaries of the evidence supporting them are provided in Table 5.8. The numbers in the judgement column are from the CBAM IC in Appendix A.

Table 5.8
Judgments for the RE teacher on the CBAM constructs

Construct	Judgement	Evidence
IC		
Access to ICT to support Assessment	(1) Teacher has access to ICT for assessments at all times.	Teacher had access to a computer lab and the Internet for the Engineering course.
Digital Forms of Assessment	(3) Teacher uses no alternative ICT assessments with her course.	Teacher used computerised worksheets of circuit diagrams for with students. No evidence was apparent of actual application of ICT for assessments in her course.
ICT and Pedagogy	(2) Teacher uses ICT for most learning activities.	Teacher used computers and the Internet for research with her students. She used PowerPoint and overhead projections for presentation and for preparation of resources. Her students kept a digital portfolio.
SoC	(3) Management	Teacher was more concerned with process and resource, i.e. PowerPoint and overhead projections. She used ICT for presentation and preparation of resources.
LoU	(3) Mechanical	Teacher had integrated some ICT into her lessons, but not for assessments in her course. She was a keen and competent user of ICT in general and had implemented the exam for the study.

Conclusions about the attitudes and perceptions of RE Teacher

In this section the discussion is centred on the summary of CBAM judgements in terms of the set of attitudes and perceptions of the RE teacher.

Attitudes and Perceptions towards using ICT to support assessment

The teacher was able to access ICT for assessment most of the time. However she had no plans for ICT to support assessments at this time, believing that using digital forms for assessment had potential to consolidate students' learning and provide meaningful feedback. Some activities for students were felt to be an interesting way of developing an ICT classroom learning culture, and introducing a level of ICT use in supporting assessments. She was enthused to have her class involved in this study and would have liked more of her students to be undertaking more research online. She was a confident user of ICT, believing using computers for assessment consolidated students' ICT skills. She had already integrated ICT into her curriculum, employing ICT to support some aspects of assessment in her class. She was willing to test other digital forms of assessment for her course.

Attitudes and perceptions towards ICT, pedagogy and the course

The teacher incorporated computerised worksheets, and used a variety of graphical applications of the computer, such as, CAD, Sketch and Paint with her students. She deployed ICT keenly, engaging her students to undertake research and a digital portfolio on the computer, thereby developing ICT use in the course. She encouraged her students to access the Internet for research work during class time, preferring her students engaged 70% to 80% of their time using computers in the learning environment. The teacher had a positive attitude towards the value of ICT in the pedagogy for the course.

Attitudes and perceptions towards ICT supporting the Engineering exam

The teacher was generally satisfied with the exam; however she was not satisfied with the exam instructions to the students, suggesting the timing of some of the tasks could be improved, a visual time display enabling them to manage time better. This would assist students in pacing through the 'timed' activities in the exam and minimise 'waiting' time for those completing the activities quicker than others. Overall she had a positive attitude towards the approach used in the exam, perceiving it to be a valid assessment in the course.

Conclusions about the attitudes and perceptions of RE Students

In this section the discussion provided a summary of results from the student survey and forum outcomes regarding attitudes and perceptions of the students.

Attitudes and perceptions towards using ICT

Generally results from the student survey showed they were mostly positive towards using ICT. They spent a similar amount of time using computers at home for their schoolwork compared with the population, and they believed computers to be useful, assisting with their assignments.

Attitudes and perceptions towards ICT and learning in the course

Generally students enjoyed learning with ICT and most were familiar with it its use in their daily learning activities. However, some ESL students this cohort who need more time in improving their application of ICT in learning; these circustances may have impacted negatively on their attitude towards ICT and learning. Most students were activating ICT in their normal class lessons, though some needed extra support, but they were not daunted, evincing a very positive toward acceptance of ICT in the Engineering Studies course.

Attitudes and perceptions towards ICT supporting the Engineering exam

These students were able to complete the exam with the support of ICT, displaying generally a positive attitude towards a computer-based exam, although some agreed they could not follow the exam instructions. None the less they were positive, agreeing it to be advantageous for ICT to support the exam. They acknowledged showing their best work with computers and having a preference for future Engineering Studies courses being examined in this manner.

Case Study WE: Public School

The WE case study involved two classes of Year 11 involving 22 students who participated in this assessment task: they were completing the Engineering Studies course Units 2A-2B. The project was to design an Eco Tricycle – Ecowarrior. Students worked at their own pace for their allocated sub-tasks, coming together frequently to discuss process and assembly protocol. They worked in groups of 5 and had access to a computer for design work. Some of the programs used the applications Auto-CAD and Photoshop.

Implementation, technologies and issues arising

The form of e-Scape system used at this school was a wireless LAN Intranet. All the students were issued with ASUS EeePC netbook computers, wirelessly linked with the research facilitator's laptop computer. This method of implementation was chosen because the school's curriculum computer network system was configured with highly restrictive levels of security access for students. Students' logon accounts were mostly protected by firewall settings and students' logon scripts, with limited write access to the school curriculum server; some Internet sites were blocked. This ICT situation was not suitable for students undertaking an exam online that required them to have a degree of read and write access, and to upload files to the e-Scape examination server.

The room selected was a computer lab which had some computers in the room and some worktables (see Figure 5.7). Reorganisation of the room was necessary in order to provide the students with space for the netbooks and desk space for their modelling activities. They used these netbooks to complete the engineering assessment task. An external web camera and mouse accompanied each computer. While the exam was completed successfully, it was a little cramped.

Results from data analysis

A range of data was collected and analysed, including observation of the classes, an interview with a group of students, an interview with the teacher, and a survey of the students. The results of analysis from each of these data sources for this case study are discussed separately below. Finally, a summary based on all sources of data is provided as a CBAM analysis and conclusions.

Observations of the class

Members of the research team visited the classes on three occasions (01/08/09, 14/10/09 and 15/10/09) to conduct the assessment tasks and to collect qualitative data.

First visit: testing modes for delivering the assessment task (Internet/Intranet)

On the first visit (01/08/09) setting up and the testing was done on the school's ICT equipment to ascertain and correct where necessary, whether the assessment task would run on this system. It was decided the best approach was to use the netbooks via Wi-Fi technology through the facilitator's local Intranet.

Second visit: examination and student survey

The two classes took the exam on two different dates (14/10/09 and 15/10/09); on both days students were implmenting the task with their netbooks being logged on wirelessly via the local Intranet to the facilitator's laptop computer as the examination server. The latter was then able to monitor each logged-in student's progress throughout the examination tasks and stop or extend a task if necessary. The activities of the examination were uploaded progressively to the exam facilitator's laptop computer.

Figure 5.6 A photo of part of the WE computer room

All students were paired in order to critique of each other's sketches. However, during the exam minor technical problems with the use of the webcam occurred which entailed minor adjustments to the focusing of the aperture setting in order to obtain a clearer image. This happened to a number of the webcams which froze during the students' 30 second video presentations. A small number of netbooks needed re-booting to connect during the initial logon stage. The timing of individual activities caused some concern for students who completed their activities quicker had to wait for the slower students to complete before moving to the next activity. Some of the examination tasks should have been divided further, for example, the sketching and then taking a picture of the sketch should be two tasks. Generally the students accepted these minor difficulties and the exam proceeded satisfactorily.

Survey of Students

Twenty-two students completed the survey questionnaire that comprised 58 closed-response items and two open-ended response items. A summary of descriptive statistics for the closed items is listed in Appendix H

Closed Items

For item E1a, six students (WE102, WE106, WE107, WE108, WE109 and WE122) indicated they had completed many design work applications on a computer before with nine more (WE101, WE103, WE104, WE105, WE111, WE112, WE115, WE117 and WE120) admitted some familiarity. Two students (WE113 and WE118) indicated they did not utilise and another six E1b students (WE115 ,WE118), indicated need much time to become familiarise design work on a computer. Four students (WE102, WE103, WE121 and WE122) noted the

adequacy of the time allotted for doing design work on a computer. Item mean difference effect sizes of absolute values for E1 were between 0.25 and 0.4 conveying they were as experienced as the population.

For E2 items, most students agreed it to be joyful and within thier competence when completing the design project in the exam. They considered the computer assisted them to develop their ideas in a manner which allowed them to exhibit their best quality work. The means for E2 items were above the population mean apart from (a, d, e, f, and g), which were about developing, recording, designing and compiling their ideas and portfolios. Item absolute mean difference effect sizes were between 0.0 and 0.3 proof that this cohort of students was similar to the population in determining the efficacy of the design project in the exam.

For Q5 items, four students (WE101, WE104, WE106, WE109 and WE115) denoted they used the full range of the items listed in Q5. Most of them signified their use of an mp3 player, laptop computer, game console, mobile phone and a computer. The least used tool was the webcam. Absolute item mean difference effect sizes were between 0.0 and 0.3, revealing these students were similar in their experience and use of computer technologies to that of the population.

For Q6, all students but one confessed to having access to Broadband Internet at home, one student not having Internet access and not using a computer at home. An effect size of -0.11 revealed them to be similar to the population with this type of Internet access.

For Q7, most of these students affirmed the employment of a computer most days at home, two students who indicating the use of a computer most weeks. An effect size of 0.36 they approximated the population in terms of using computers at home.

For Q8, these students spent slightly less time on average using computers a day at school (36 minutes) than that of the population. Item mean absolute differences effect sizes were between 0.3 and 0.5 confirming them to be very little different in the amount of time spent using computers each day a week at school.

For Q9, thirteen students denoted they touch typed using all fingers, seven students revealed not touch typing at all, and two students did respond. An effect size of -0.02 showed these students touch typed at a level similar to that of the population.

For Q10 items, most students reacted positively to the range of applications listed, in particular Q10 c, d and f, which concerned typing an assignment, using a line or pie graph or

using social network communications. They were less positive about keeping a list of addresses of friends and drawing a diagram or picture (Q10 a and b). Item mean absolute difference effect sizes were between 0 and 0.6 confirming they were similar to the population in their use of various computer applications.

For Q11 items, most students again intimated positivity towards using computers at school and at home. Largely they believed computers to assist in completing their schoolwork. A smaller number (six students) avowed to enjoying computer use at school. Item mean absolute difference effect sizes were between 0.0 and 0.4, affirming these students on average to have a positive attitude towards using computers similar to that of the population.

For Q12 items, students averred they were generally confident in using computers. The exceptions occurred in Q12e wherein student WE107 doubted his ability to learn to program a computer, and Q12f in which students WE110 and WE112 repeated they found it difficult to use a computer in the assessment, but usually were competent with computer use. Item mean absolute difference effect sizes were between 0.0 and 0.2 proving that, on average these students were similar in their level of confidence in using computers as the population.

For Q13 items, most students were positive about their levels of skills in applying most of the software applications. Most students indicated they could use most of software listed. Generally students in confessed their being less skilled in databases, webpage authoring and video editing (Q13 c, h and k). Item mean absolute difference effect sizes were between 0.0 and 0.2, again idicating these students were similar in skills to that of the population regarding computer application software.

Open-ended items

Students responded to two open response items to indicate the two best and worst things about the exam. A summary of their responses is included in Appendix L .

The two best things were students agreeing that it was easy completing the assessment using a computer, and the enjoyment of doing the tasks. Some students indicated being faster to type than write. The WE101 agreed the computer assessment was interesting and relevant to the real world. They believed engineers ultimately become competent in computer use for design. Student WE108 signified computer assessment made it easier for him to record his ideas and apply them. Generally students considered that using computers in the exam helped them in doing the assessment.

In the instances of the two worst things about a the computer-based the exam recorded most frequently were concerned with relatively minor technical problems affecting their recording of ideas and presenting their models for peer evaluation. Most of these were hardware issues, some with the initial setup and others during the course of the assessment. However they were generally happy and comfortable with the assessment process.

Questionnaire scales

Six scales were derived from combining items from the questionnaire (see Chapter 3, Table 3.3). Descriptive statistics for these scales are recorded in Table 5.9 and Figure 5.7 with their discussion below.

Table 5.9
Descriptive statistics for the student survey scales for the WE class

Scales	WE Class					Population		Sample
	N	Min	Max	Mean	SD	Mean	SD	Effect Size
eAssess	22	2.00	4.00	3.18	0.60	3.16	0.50	+0.04
Apply	22	1.60	2.80	2.33	0.38	2.38	0.38	-0.13
Attitude	22	1.40	3.00	2.55	0.37	2.63	0.32	-0.25
Confidence	22	1.67	3.00	2.72	0.33	2.77	0.29	-0.17
Skills	22	2.64	4.00	3.31	0.33	3.27	0.47	+0.08
SCUse	22	0.00	168	36	39	58	50	-0.44
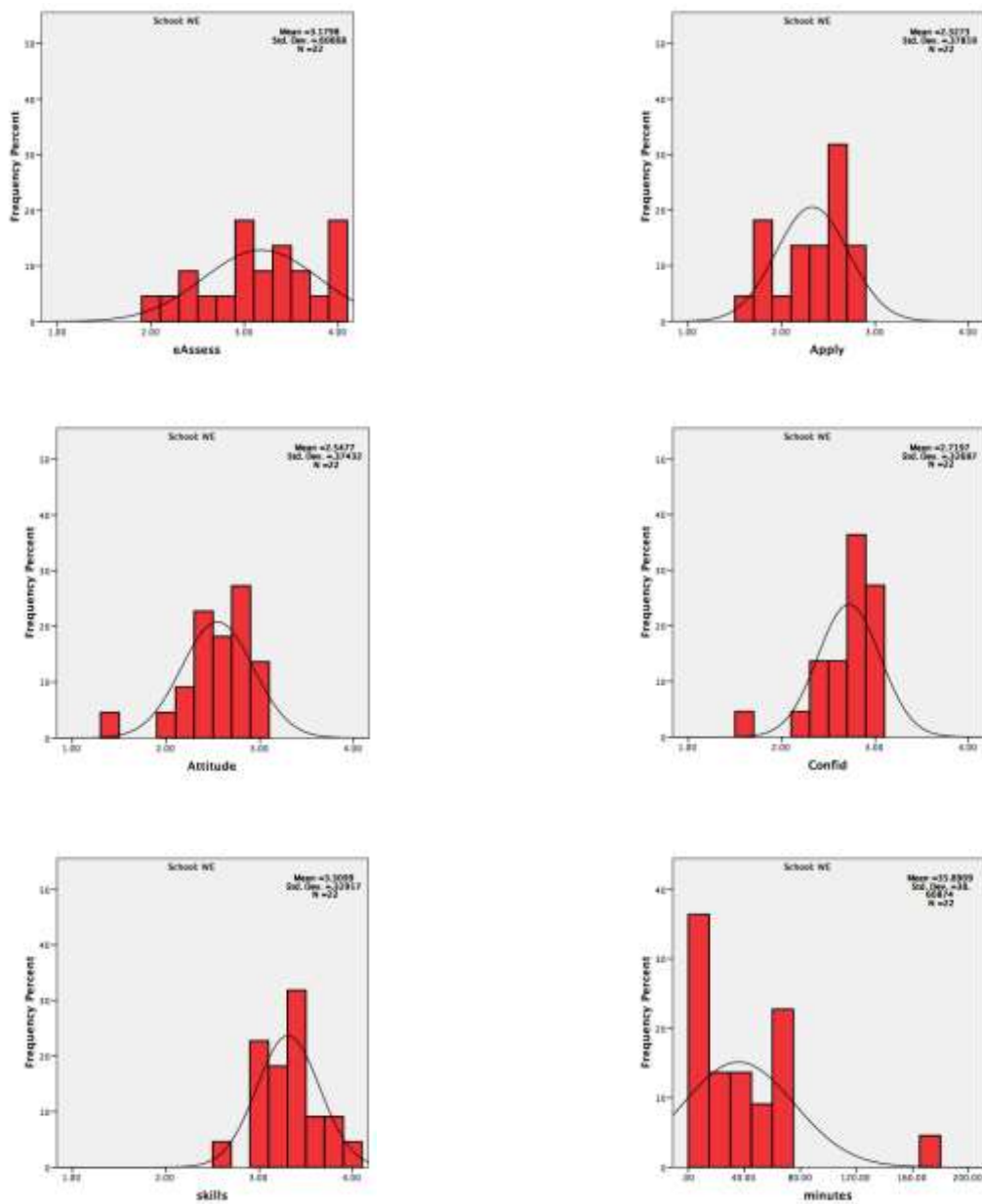
Figure 5.7 Distribution of scores for the student survey scales for the WE class

The eAssess graph shows that most students warranted means between 2.50 and 4.00 with a mean of 2.97 and a standard deviation of 0.40, skewed positively. The mean for eAssess was below the population mean with a smaller SD. Four students in this class were negative to one or more items listed in (Q2a b, c, f, i and k). These items concerned the efficacy of using computers in the engineering exam. An effect size of +0.04 indicated that the average for these students was similar to the population on this measure.

The Apply graph reveals a good spread across the range with a relatively large number of students falling in the range between 2.50 and 3.00, with a few below 2.0. This showed the students tended to apply computer applications to a range of contexts listed in Q10. However, an effect size of -0.13 indicated them to be similar to the population.

The students' Attitude graph was skewed positively, showing most students scoring above 2.50 with a mean of 2.55 and SD of 0.4, which indicated students tended to display a positive attitude towards using computers. An effect size of -0.25 them to be similar the positive attitude of the population.

The Confidence graph was skewed positively, revealing a mean of 2.70 and, SD 0.30 most students scoring above the mid-point of 2.8. This indicated most students in this cohort tended to be confident in their beliefs in the contexts listed in Q12. An effect size of -0.17 indicated that they were relatively similar attitude to the population.

The Skills graph was skewed positively with a mean of 3.19 and SD 0.47. Most students scored above the mid-point of 3.5 showing their perception of ICT skills were relatively high. However an effect size of +0.08 pointed they being similar to the population in these skills.

The SCUse graph was skewed negatively, most students indicating they spent approximately 36 minutes on average each day using computers at school. These students apparently spent less time per week using computers at school. An effect size of -0.44 reviewed that on average they used computers a little less than the population.

WE Engineering students' forum

The forum of students gathered for discussion, sitting at the front bench in a classroom. A transcript of their deliberations is included in Appendix D.

Generally students were happy with the exam; however some were concerned and felt frustrated with technical issues such as the quality of the webcam and momentarily interrupted power supply to the mini computers were being used for the assessment. They would prefer not having to wait for all students to complete a task before being allowed to move on to the next task. Some found the wording of some tasks too vague. They believed displayed their best quality work and that the computers helped them. All agreed the exam was very different to to the usual written format, the computer use for designing their project being very different and requiring different skills. These students suggested changes including the employment of full size keyboards with the mini computers and provision of better quality webcams. Some students commented this exam reflected the reality of a course with practical components, and such forms of assessment should be applied to future assessments in Engineering courses. Overall the students completed the exam in the allocated 3 hours.

Pre-interview with the WE teacher

The WE teacher provided feedback by an emailed return to a set of questions prior to his class becoming involved in the assessment (Appendix G). The following is a summary of responses to the questions.

The teacher indicated his students used computers for assessment and design purposes. However, he was not sure computers could be used to promote more authentic assessment in the future; thus he was seeking more information about employing computers for assessment, as he had no specific plans for this type of assessment. He had used computers specifically for research with his students but felt it necessary to engage his students in using computers, preferring his students had access to computers during 70% to 80% of the Engineering Studies course. He was positive and willing to embrace computer assessments in his class.

Post-interview with the WE teacher

The teacher provided feedback by way of an email return to a set of questions after his class completed the assessment (Appendix J). The following is a summary of responses to the questions.

The teacher commented that the assessment tasks were good, but designing a product was a struggle for some students; many needed extra time to complete the task. Overall the timing was good, with the tasks broken into smaller tasks. He commented that some of his students bogged down with one section and did not complete the whole task. However his students were positive about the value of using computers for the exam. He believed this type of assessment could have huge potential for practical courses, such as the Engineering. The quality of work produced by students was good, they were a good group and the teacher expected them to do well. There were no technical problems with implementing the assessment activities.

Overall the WE teacher indicated he was positive towards the exam reporting all students completed the exam in the allocated time. He indicated that he was keen to see this form of assessment taken up in future Engineering Studies courses. He was positive towards supporting the exam.

CBAM Analysis

The results of the analysis of data from the previous sections are now used to make judgements for the three constructs of the CBAM:- (IC); Stages of Concern (SoC); and Levels of Use (LoU) that were employed as a diagnostic tool for analysing the implementation of digital forms of assessment for this teacher. The outcomes of these judgements along with summaries of the evidence supporting them are provided in Table 5.10. The numbers in the judgement column are from the CBAM IC in Appendix A.

Table 5.10
Judgements for the WE teacher on the CBAM constructs

Construct	Judgement	Evidence
Innov/Config Access to ICT to support Assessment	(1) Teacher has access to ICT for assessment at all times.	Teacher was timetabled into a computer lab and had access to ICT.
Digital Forms of Assessment	(3) Teacher uses no alternative ICT assessments with his course.	Teacher was seeking information about using computers for assessments and digital portfolios with his students. Teacher required students to keep a digital portfolio. He met with students on a weekly basis and shared portfolio and ICT design strategies
ICT and Pedagogy	(2) Teacher uses ICT for some learning activities.	Teacher used PowerPoint and CAD for some design projects with his students.
SoC	(1) Informational	Teacher would like to see more of his students doing research online. Perhaps this could lead to some initial preparations for ICT supported assessments.
LoU	(3) Mechanical	The opportunities to ICT for assessments were as evident, but he had no plans at the moment.

Conclusions about the attitudes and perceptions of WE Teacher

The discussion below centres on the summary of CBAM judgements on the set of attitudes and perceptions of the WE Teacher.

Attitudes and perceptions towards using ICT to support assessment

The teacher was able to access ICT for assessments at all times, his students were encouraged to do their research online. He was keen to apply ICT to support assessments with his students, but had no specific plans on the implementation of digital assessment at this stage.

The teacher had a positive attitude being keen and participated enthusiastically with the computer-based assessment for his two classes. He used digital portfolios for assessment and

learning, meeting with his students once a week to share their digital portfolio of work. He was eager to see more of his students using ICT in their research. However he was uncertain computers alone could be used to promote more authentic assessment in his classes.

Attitudes and Perceptions towards ICT, pedagogy and the course

The teacher believed the delivery of the Engineering course work should be based more on using computer applications such as CAD and CAM. He believed that this would be one way students could enhance and embrace ICT in the curriculum. He had a positive attitude towards ICT supporting the curriculum and had shown a positive approach to ICT driving pedagogy. The teacher was familiar and a regular user of ICT with his students in the Engineering course. He believed ICT was part of the course and students should engaged ICT in doing the course. He was strongly positive to the value of ICT in the course.

Attitudes and Perceptions towards ICT supporting the Engineering exam

The teacher believed ICT was needed and supported the exam, appropriately aligning with the practical required tasks of them. He was strong in his positive support of this format for future Engineering Studies exams.

Conclusions about the attitudes and perceptions of WE students

In this section the discussion is concerned to summarise the results from the student survey and forum discussinn relevant to the attitudes and perceptions of the students.

Attitudes and perceptions towards using ICT

Students employed ICT on a daily basis at school and at home. They believed Engineers in the work place used computers in their profession, and that computers were good for the world. Generally they had a positive towards using ICT, most being confident in using ICT in the Engineering course.

Attitudes and perceptions towards ICT and learning in the course

They enjoyed learning with computers, most using ICT on a daily basis in the pursuit of knowledge and decisionmaking. They indicated learning in a practical environment needed ICT support, this being particularly apt for the Engineering Studies course. Students foresaw the Engineering course to be a practical one, therefore problem solving was assisted by ICT.

The course had a strong design and create component process, thus it would be relevant and meaningful to demonstrate the technological processes with the support of ICT.

Attitudes and perceptions towards ICT supporting the Engineering exam

Students considered the exam was relatively simple, indicating computer use asssisted them in their design ideas and hence they were able to produce quality work. All students demonstated a positive attitude towards a computer-based exam.

Summary and Conclusions from the Engineering Case Studies

This section summarises the five Engineering Studies case studies and discusses the findings related to the students' and teachers' attitudes and perceptions about the use of ICT and its implementation in the exam. Then the implementations between the five case studies are compared followed by a mapping of each teacher relative to the CBAM constructs (IC, SoC and LoU) is created (see Table 5.11).

Summary about the implementation of the Engineering studies exam

Seven Engineering studies teachers of senior secondary classes with a total of 84 students were involved in the implementation of the Engineering Studies exam. All schools involved in this study had similar in workshop facilities and they used the computer labs in their schools. Thus the Engineering studies exams were conducted in the computer labs in each of the five schools involved in the study. There were no issues in the implementation and all students completed the within the set time required.

Similarities and differences between implementations

The structure and context of the exam were similar for the Engineering case studies implemented, all schools following the same process and procedure. The only major variation of the implementation was between GE and HE schools where logging in procedures differed. In the HE case two groups of students were logged on simultaneously while the other three schools, LE, RE and WE used the laptop computer to act as the local server broadcasting to students' via the EeePc netbooks. All students were issued with ASUS EeePC netbook computers, wirelessly linked with the research facilitator's laptop computer.

Two schools (a private HE and a public WE) each with two classes participating in this research. The HE school had two Engineering Studies teachers involved and WE had one. There were no logistical difficulties with implementation in these two schools. Any technical issues with hardware were satisfactorily addressed during the early stages of implementating the examination process the latter never being comprised.

All computer labs in the schools involved in this study were similar in infrastructure thus not giving rise to any implementation difficulties. Some exams were conducted in the morning sessions and some were in the afternoons with no major implementation difficulties throughout. However the normal difficulties encountered, such as, students logging on incorrectly or poorly performing computers being mainly small technical challenges which were rectified early in their operation

Attitudes and perceptions of Engineering Students

Implementation of the Engineering studies exam

The seventy nine Engineering students came from the five schools involved in this study. Most students were able to complete their Engineering design project exam with ease. This was partly due to their having enjoyed the practical experience; they tended to feel a natural affinity with their study in the Engineering course. Therefore completing the design project exam would appear seamless to them. They perceived the task was simple because it related to the skills needed for a computer-based exam, and the assessment tasks complemented the nature of the course.

Attitudes and perceptions of Engineering Teachers

In this section comprises the summary of CBAM mapping for all groups of teachers; it will discuss judgements made concerning teachers' attitudes and perceptions (see Table 5.11) .

Table 5.11
CBAM mapping for Engineering teachers

Teacher	IC			SoC	LoU
	Access	DFA	Ped		
GE	1	3	2	2	2
HE	1	3	2	3	3
LE	1	3	2	2	3
RE	1	3	2	3	3
WE	1	3	2	1	3

The CBAM mapping all teachers shows all three components of teachers were judged the same. They all had access to ICT in supporting assessments at all times and so were judged 1 on the Access component. Although they performed most of the practical activities in specially equipped workshops, they were accommodated/timetabled into a computer lab. Therefore there were ample opportunities to access ICT to support assessments as evidence by the rating of 1 for all teachers on the Access component. Although teachers were aware of the potential, the value of ICT supporting assessments was not realised in their course with all being rated 3 on the DFA component, that is, 'Teacher uses no alternative ICT digital forms of assessments with his course'. They tended to use ICT mainly for presentation and sometimes for other learning activities such as designing, simulation, keyboarding, report writing, researching, programing and printing. All were rated 2 on the Pedagogy component, that is, 'Teacher uses ICT for some learning activities'. Perhaps they found this more engaging for learning activities.

The SoC judgements clearly demonstrate most teachers to be uncertain about the demands of the use of ICT for assessments. The HE teacher was judged to be at stage 3 'Management' with respect to his use of ICT, this being evidenced from his comments of concern were about promoting the process and tasks using ICT for authentic assessment in Engineering. He was instrumental in exploring ICT, computer-based exams and tests specifically with CAD and digital portfolios with his colleagues in the Engineering faculty. The RE teacher of stage 3 was similarly mapped where her concerns were about the authentication of ICT use to support exams, tests and experiments in her course. She had produced worksheets of circuit-diagrams as a means of capturing authentication in her students' understanding of wiring diagrams for her course projects.

221

Both the GE and LE teachers of their stage 2 were towards 'Personal'. This was evident from their comments in the first interview discussed 'sharing' and 'engaging' with ICT (GE), and using Robotics as a vehicle for engaging students in learning (LE). Their perceptions of strength and adequacy with ICT mainly focused on their role, little concerning the demands made for the use of ICT for assessment in the course. Their concern was about ICT supporting student-learning activities through visualisation/simulation. Perhaps for these two teachers, inadequacy to meet the demands of the use ICT for assessment could be another reason for their not embracing ICT assessment currently.

The WE teacher of stage 1, Informational' was somewhat indifferent to ICT for assessment purposes because he was unsure how computers could be used to promote more authentic assessments and had no specific plans to do so as, evidenced from the response to Q4 in the initial teacher interview '… *no specific plans about using computers for assessment'*. The WE teacher seemed to be unworried about himself in relation to the use of ICT for assessment, having focused on ICT use essentially on student learning activities, such as PowerPoint and CAD for some design projects with his students. Generally, all teachers in all case studies reflected an awareness of, and personal commitment to using ICT in the Engineering course; they were at the early stages of commitment to using ICT to support assessment.

The LoU judgements clearly demonstrate that most teachers in this group had a low level of use of ICT for assessment and were in the early stages in adopting ICT use for assessment in their course. Four teachers (HE, LE, RE and WE) were rated 3 ('Mechanical use') which regarded teacher 'centred'/'focused' use of ICT for assessment. Such use results in little time for reflection and often tends to benefit the user (teacher) rather than students. This use of ICT for assessment tended to engage the them in a stepwise attempts to improve teacher skills in the use of ICT for assessment, which could be superficial. This was evidenced from their comments on the first interview wherein they indicated:

> '... *used computers specifically for CAD, Photo Imaging Logbook and data logging, portfolios and reporting writing'* HE.
>
> '... *used computers for theory and research assignments'* LE.
>
> '... *used computers for class theory, research and printing'* RE.
>
> and '... *used computers specifically for research with students'* WE.

Four teachers' (HE, LE, RE and WE) LoU of ICT could be linked to their beliefs that computers could help in engaging their students in learning activities, but with not much thought on authentic assessments for their course. They tended to focus mainly on ICT for student learning. They used ICT primarily for engagement and learning purposes, focusing mostly on short-term interactive strategies, with little evidence of more than passing interest in assessment.

The GE teacher was mapped at (Level 2 'Preparation') being at an earlier stage of preparing for the use of ICT for assessments. This was evident from the his first interview where he commented: *'… regular user of ICT with lessons, reinforced student learning with ICT use'* Although GE was keen and willing to support developing the use of digital forms of assessment, he had only implemented the assessment for this study; thus at a level 2 ('Preparation') he was considered (CBAM) preparatory with regard to the first use of ICT for assessment.

Summary

This chapter has reported on and analysed the results of data collected from each case study school in Engineering Studies.

Students and teachers were keen to use ICT which suggested they preferred future Engineering exams to be of similar format to that implemented in this study. All teachers involved in this study had the experience of implementing ICT to support assessment in the course. They perceived ICT use had supported students' in the exam and given them the opportunity to perform optimally at their personal level. All teachers were satisfied about the manner in which the computer-based exam was implemented, the content in the exam reflecting a high degree of realism concerning practical processes in the Engineering Studies course. Most teachers and students agreed it was easy to follow the exam instructions. Feeling generally amongst the Engineering cases was of a strongly positive endorsement towards the value of ICT to support learning and assessments. In their second interview teachers indicated satisfaction if similar format of exam became common in future Engineering Studies courses. In addition, they deduced that students were mostly keen to use computers for doing their exam tasks, believing that computers assisted them to produce quality work in the exam.

The next chapter will present the results of the data analysis on a case-by-case basis for each of the five schools at which the AIT exam and the digital portfolio were implemented.

CHAPTER SIX:
AIT CASE STUDIES

This chapter presents the data analysis on a case-by-case basis for each of the five schools at which the AIT exam and the digital portfolio were implemented. For each case the background is discussed prior to a presentation of an analysis of the data from the observations, student survey, representative student forum, and teacher interviews. At the conclusion of each AIT case study, the findings from the analysis of all data are combined to complete a CBAM analysis for the teachers, followed by a set of conclusions. Prior to presenting the analysis of data for each case study background information relevant to all cases is presented.

The researcher visited each of the teachers a number of times before their students became involved in the project. These visits were to discuss the processes for the portfolio and exam, and to decide which classroom and what dates during the school term were most appropriate to implement the AIT exam. It was also necessary to check and test the technologies required for the exam. In some cases photographs were taken of the room in which students completed the assessment. This occurred on one of the two visits during which students were working on the portfolio. The final visit on the day of the exam had the researcher proctor the exam and collect qualitative data.

Communications between the researcher and the teacher were mainly by phone and occasionally via email before the students became involved. These contacts were to discuss the research and assessment processes determine exact time and location the components of the assessment task would occur.

Case Study NA: Public School

The NA case study involved one teacher and a class of 17 Year 12 students completing the AIT course units 2A-2B; their study focus was on Business Information Technology Students in this class were of both genders and from various ethnic backgrounds.

Implementation, technologies and issues arising

The room selected for the examination was the regular computer lab used by the class, having computers around the walls of the room and two rows of computers in the centre (Figure 6.1). The students' computers were all less than three years old and well equipped with office and multimedia software; however when multi-tasking with large files the computers often slowed down considerably. The school's curriculum computer network system was configured with highly restrictive levels of security access for students, perhaps causing loss of computer operation. Students' logon accounts were mostly protected via firewall settings, their logon scripts having limited write access to the school curriculum server. Students employed MS Office Word for both the portfolio, while for exam they used MS Excel spreadsheet for particular tasks. In addition to word processing they employed multimedia tools (PowerPoint) for presentation and designing the website for the portfolio.

Figure 6.1 A photo of part of the NA computer room

Results from data analysis

A range of data was collected and analysed, including observation of the class, an interview with a group of students, an interview with the teacher, and a survey of the students. The results of analysis for each of these sources of data are discussed separately below A summary based on all sources of data is provided as a CBAM analysis and conclusions.

226

Observations of the class

Members of the research team visited the class on two occasions, conducting the exam and collecting the qualitative data. This was the only school in which the exam was conducted over two consecutive days, due the constraints of time allocation in the school's timetable.

First Visit: portfolio product and design process development

During the first visit students were studying on their digital portfolio in class. They were designing a website for an online sports store. The teacher had them follow the design brief provided exactly as intended with the only change being the context for the design. Students were working on the production phase of the interactive display doing their planning on templates provided by the teacher. These templates formed the basis for their storyboarding and design processes that was required for the Design Process Document in component two of the portfolio. The focus of the activity was the application of the whole technology process to a real-world context, as set out in the scenario contained in the design brief.

Most students worked independently, discussing with project matters with each other. They developed the prototype website using PowerPoint, exporting exported in an html.index file format. Students kept a reflective journal of their product development and showed their evidence of brainstorming/planning.

Most students were competent in their storyboarding and had completed hand-drawn storyboards and timelines. Some completed storyboarding for component one of the portfolio. Other students worked on component two which concerned the Design Process Document (DPD). The technological process was evident in students' planning which included investigation and brainstorming. Generally students followed the stages of the DPD with good planning outcomes. They were given equal time to work on their process document and the product development. The teacher worked with some of the ESL students in this class, these students having no previous experience with digital portfolios.

Second visit examination and student survey

The exam was conducted during the second and final visit; student NA116 was absent while NA117 had been added to the class. During the exam two students asked for an explanation of an "interactive display". This was given and the opportunity to complete the exam. A few students who wanted to use coloured pencils for their plan were advised use normal black pencil. Two students were confused about completing the poster which the researcher

227

clarified so enbling them to continue with the exam. Six students had problems opening data.txt file in Excel, another required clarification about the graph in the exam. Several students needed more time to finish the exam. Perhaps these students had spent too much time on the prototype, and lacked subject content literacy. The exam was completed by 15 students during the two consecutive days.

On completion of the AIT exam, students were presented with a survey. Not all students completed all the survey items. A student forum, consisting of of 4 students, was convened by invitation of the teacher. The group were presented with the same structured interview questions which were followed up with random questions according their responses. This added clarification to the responses in eliciting their attitudes and perceptions about ICT support for the assessments.

Survey of Students

Fifteen students completed the closed and open items in the survey. The results of analysis of each item for this case are discussed in this section. A summary of descriptive statistics for the AIT closed items is listed in Appendix K.

Closed items

For item E1a, nine students reported they had some experience an exam or test on a computer previously, and for item E1b seven students needed more familiarity before proceeding comfortably. Two students, NA103 and NA114, confessed to not having done any exams or tests on computers thereby needing much more time to become familiar. The item means for E1a and b were 4.40 and 2.67 respectively, a measurement above the population means. Item mean difference absolute effect sizes were between 0.11 and 0.31, indicating this student cohort to be similar to the population.

For E2 items, some students were positive about the value of using computers in doing the AIT exam. Five students (NA102, NA103, NA104, NA110 and NA111) were positive about the degree to which ICT supported the assessment, and the computer had assisted them. Student NA104 was indifferent considering he did not find using a computer helped him at all in designing and developing design ideas. Student NA101 suggested that the using a computer did not allow his talents to shine. Item means for E2 ranged from 1.79 to 3.40, which were relatively above the population means. However, with item mean difference, absolute effect sizes between 0.0 and 0.6 (E2b and h) showed the group was similarly positive to the

population regarding the efficacy of a computer-based exam. Items E2e and h were the exceptions with relatively higher absolute effects sizes of 0.6 and 0.7, indicating some students were relatively less positive about using computers for reflecting on and developing their design ideas in the exam.

For items P1a and b five students (NA103, NA104, NA105, NA107 and NA109) indicated that they had not done portfolios using computers previously, all but one needing time to become familiar, that person feeling confident enough to proceed. However, most students admitted having completed a portfolio on a computer previously, but still needed some time for familiarisation. Item means were above the population mean with a slightly larger spread for item P1b (SD of 1.30). Item mean difference absolute effect sizes were between 0.2 and 0.3 revealing these students were not significantly different from the population.

For all P2 items, most students affirmed it to be easier completing the AIT portfolio computer facilitated for various aspects of the portfolio. One student (NA104) averred he was most positive towards all aspects of the portfolio, and another (NA105) gave no responses to the P2 items. Overall most students were positive about the ease of completing the AIT portfolio. The item means for P2 ranged from 1.60 to 2.80. Item mean difference absolute effect sizes between 0.0 and 0.4 pointed out these students to be similar to the population's positive perception about the digital portfolio.

For Q5 items, students generally deployed at least six of the devices at home ranging from computer to webcam. Two students (NA103 and NA110) used all the devices; three students (NA104, NA105 and NA112) were the only students who did not use any of the devices. Item means of 0.47 to 0.80 were mostly above the population with an item mean difference absolute effect sizes between 0.1 and 0.2 showing these students to be similar to the population concerning the use various computer technologies at home.

For Q6, most students indicated that they had access to broadband Internet, with the exception of students NA104, NA105 and NA115 who indicated that they had no Internet access at home. These students were relatively similar to that of the population with Internet access at home.

For Q7, most students conveyed that they used a computer most days at home. Three students only (NA104, NA105 and NA115) indicated they rarely used a computer at home. On average computer usage at home for this class was similar to the population.

For Q8 students averaged approximately 58 minutes each day using computers at school. Student NA111 was the affirming he spent the most time on a computer over the five days at school. Five students (NA104, NA105, NA106, NA108 and NA112) indicated zero usage for the five days. They may not have completed the questionnaire not having enough time. On average the class usage was slightly below the population. There was a significant variability of computer usage within the class, from no time to over 240 minutes. An effect size of 0.31 indicated that they were relatively similar to the population.

For Q9, seven students asserted they touch-typed using all fingers. However, two students confesssed to not touch-typing, and six did not respond. An effect size of 0.06 indicated the number of students who touch-typed in this cohort was similar to that of the population.

For Q10 items most students applied computers in the range of contexts listed. However seven students (NA101, NA102, NA107, NA108, NA113, NA114 and NA115) revealed they had not drawn a diagram or picture using a computer (Q10b). One student (NA108) told of not using a computer to send a letter (Q10e). The item means for this question were mostly below the population mean except for Q10b. Item mean difference effect sizes fell between absolute values of 0.3 and 0.4, pointing out these respondents were similar to the population's range of computer software applications.

For Q11 items most students in the research group were positive about the value of using computers at both school and home, believing that computers were good for home study. Four students (NA104, NA105, NA106 and NA112) did not respond. One student (NA102) was less positive about discovering new knowledge but rather hearing it from the teacher. He concluded that computers were not good for the world. The Q11 means were mostly below the population mean; however item mean difference absolute effect sizes were 0.2 to 0.4, demonstrating these students to be similar to the population in attitude towards using ICT to support learning.

For Q12 items students indicated they were generally confident when using computers. Four students (NA104, NA105, NA106 and NA112) did not respond, three students (NA109, NA111 and NA114) revealed computer use was difficult for them, and two students (NA114, and NA115) imitated not being sure for items a, b, c, d, e, and f. Item means were mostly below the population mean showing these students in general were less confident. However, item mean difference absolute effect sizes were between 0.1 and 0.6 denoting that, on average, these respondents were similar to the population in confidence with computers. The

effect size for item Q12d was higher indicating the students were less confident about doing well with computers than the population.

For Q13 items, seven students (NA104, NA105, NA110, NA111, NA112, NA114 and NA115) did not respond, and two students (NA106 and NA109) ran out of time. Student NA109 indicated that he was not capable with web page authoring, two (NA101 and NA107) admitted they were incapable of video editing. Item mean difference absolute effect sizes fell between 0.2 and 1.1. Compared to the population the respondents possessed higher skills with databases, (an effect size of 1.1), computer file management and digital photography (effect sizes of 0.6).

Open-ended items

Students responded to four open-ended response which purported to ascertain the two best and worst things about the AIT exam and the digital portfolio. A summary of responses is given in Appendices P and Q for the exam; and R and S for the digital portfolio.

The AIT exam

Generally for the two best things students considered the exam was easy and completed the exam in a shorter time. One student (NA104) he was surely able to develop his ideas better using computers, while another student (NA112) told of being able to create designs and apply a variety of content/templates. Student NA107 believed use of the computer a faster way enter his designs into the final documents. Students' responses, such as 'no need to write' and 'less hand cramps' were common among NA students.

The two worst things about doing the AIT exam in the computer lab were concerned difficulty of sketching using a mouse on a computer (NA101), and lack of reliability and precision of drawing diagrams (NA102), unloading my work (NA109), difficulty in using some of the software (NA111), and not enough time allocated for the exam (NA112).

The Portfolio

Generally for the two best things about doing the AIT portfolio, students considered that it was easy, saved time and was appropriate to the course. Student NA101 believed completing the AIT portfolio on a computer saved time while student NA112 thought computer use was applied IT in action. For the two worst things, students were concerned about the lack of

quality with the digital images compared to a paper-based product. They felt that it was annoying to put everything into the folder.

Questionnaire Scales

This section presents the seven scales derived by combining items from the questionnaire. The results are displayed in Table 6.1 and Figure 6.2. Then the results for each scale are discussed separately.

Table 6.1
Descriptive statistics for the student survey scales for the NA class

| Scale	NA Class					Population		Sample
	N	Min	Max	Mean	SD	Mean	SD	Effect Size
eAssess	15	1.91	4.00	2.84	0.58	3.03	0.50	-0.38
eAssessP	15	2.00	4.00	2.93	0.45	3.19	0.63	-0.41
Apply	12	1.00	3.00	2.42	0.51	2.39	0.38	0.08
Attitude	11	2.00	3.00	2.65	0.32	2.63	0.30	0.07
Confidence	11	1.83	3.00	2.70	0.41	2.77	0.27	-0.26
Skills	6	3.18	4.00	3.70	0.30	3.33	0.55	0.67
SCUse	15	0	156	58	51	79	69	-0.31
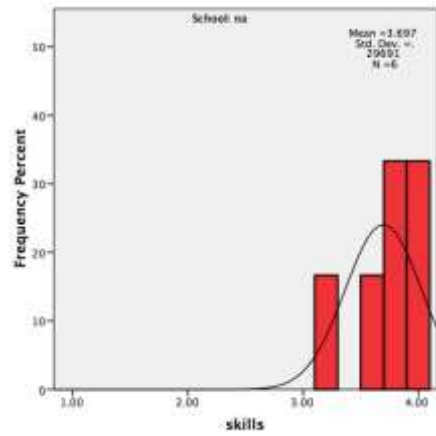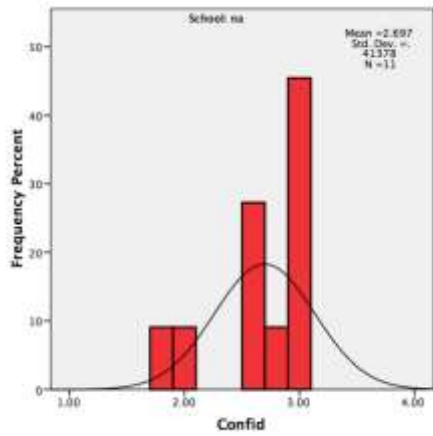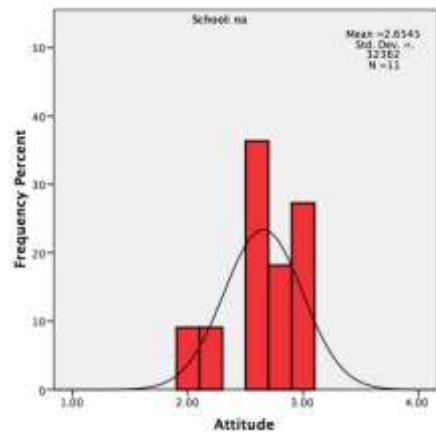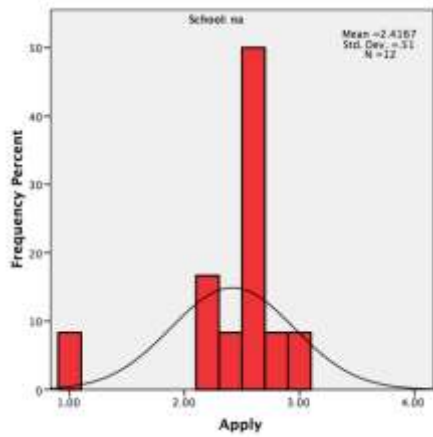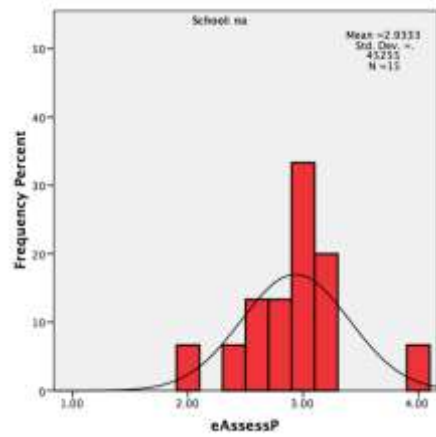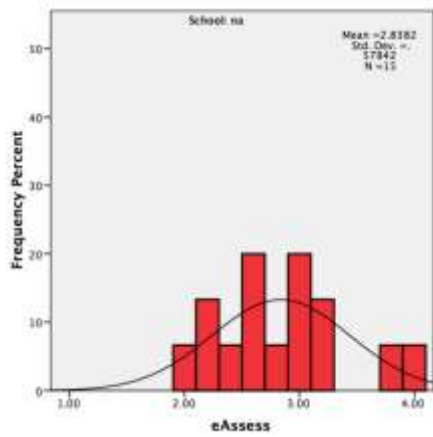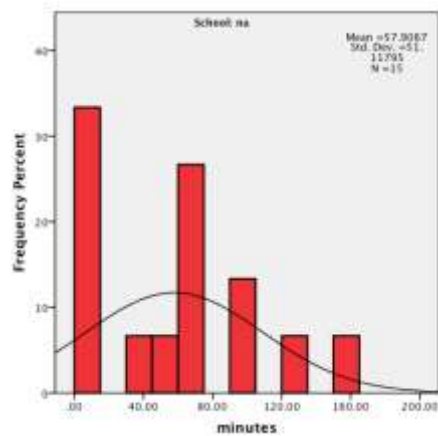
Figure 6.2 Distribution of scores for the student survey scales for the NA class

The eAssess graph showed a good distribution of students in this class with a mean of 2.84, a little below that of the population. However, with the majority of students between the midpoint 2.50 and 3.00, and with an effect size of -0.38, this cohort was only a little less positive than the population about the efficacy of computer use in the exam.

The eAssessP graph showed most students to cluster around a score of 3.00 with a small number of outliers with a top score of 4.00. The mean was 2.93 and a good distribution (SD 0.45), with an effect size of -0.41 pointing out this group was nearly as positive as the population about completing the digital portfolio.

The Apply graph had most students clustering around the 2.50 score, almost all being spread between 2.20 and 2.80. A small number of students scored 1.00. The class mean of 2.42 and SD 0.51 revealed the respondents to be mostly spread at the higher end of the scale. An effect size of 0.08 proved this class to be similar to the population in its applications of computers.

The attitude graph was skewed positivly, most students ranging from 2.50 to 3.00. The class mean was 2.65, slightly above that of the population mean with little spread (SD 0.32), and an effect size of -0.07 showing this class was similar to the population in having a positive attitude towards using computers.

The Confidence graph revealed large numbers of students clustering around the maximum score of 3.00. The class mean of 2.70 with an SD 0.41 indicated there to be a good spread within this class. An effect size with absolute value of -0.26 showed these students were similarly confident in using computers to the population.

The Skills graph was skewed positively but the data sample was too small to be conclusive about the measure of ICT skills for this group.

234

The SCUse graph showed a good spread amongst this class for the amount of time spent per day using computers at school. A large variability in the daily time computer usage was evident among this these students. On average they spent only a little less time per day using computers at the school than for the population. However an effect size with absolute value of -0.31 showed they were not significantly different to that of the population.

NA AIT students' forum

The forum students sat in a semi-circle in a classroom; a transcript of the forum's discussion is included in Appendix E.

The students explained of being happy basically when using the computer for their Portfolio and AIT exam in the computer laboratory. They believed using the computer for their exam was a true reflection of the curriculum and also the portfolio because AIT was a practical subject. They considered the manner in which the exam was conducted gave them the opportunity to demonstrate their skills appropriately. They believed there were not many positive reactions to the tasks from a few students in this class, as some of them were not interested in this subject, being enrolled in it when nor their choice of subject. Three students (NA101, NA105 and NA111) commented on not able to provide their best quality effort in the exam even though the computers helped them to type faster than they could write. Some of the responses from these students included: 'it was difficult to sketch using the computer'; 'could not open files'; and 'not familiar with the software'. Perhaps these students were challenged with literacy skills making it difficult to complete most of the tasks. Most students agreed it to be faster typing than writing during the exam, and all assessments should be similarly completed. However, they hoped for more time to be allocated to the exam in the future. Overall the students were able to complete the exam in the allocated 2 hours, over two sittings.

Pre-interview with the NA teacher

The teacher provided feedback by way of an email return to a set of questions prior to his class being involved the assessments (Appendix G). The following is a summary of responses to the questions.

The teacher remarked that the students did not use computers for assessment purposes in his class. He did not use timed assessments such as tests for them All project work was to be completed both at school and at home. He had not made any decision about using computers

for exams in the future with the exception for some form of quizzies or multi-choice web2 testing for the following year, but for his classes only. He was interested in the measurement of collaborative activities and performance in web 2.0 spaces and applications wherein student engagement strategies, self-directed learning and peer assessment mainly occurs. He commented that this should help him to judge the impact of online collaborative learning and task work with traditional group work. He reinforced student learning with ICT and would like to see his students use computers in their learning 100% of the time. He was positive about using computers for assessment, aiming that more of his students' marks (assessments) would derive from their application of IT in a practical exam. He demonstrated a positive attitude towards this method of assessment saying this research project will help in promoting digital forms of assessment across his learning area and the school in general.

Post-interview with the NA teacher

The teacher provided feedback by way of an email return to a set of questions after his class completed the assessments (Appendix J). The following is a summary of responses to the questions.

The teacher commented that overall the assessment tasks were fine and suited the stage 2 AIT course. Students were initially disoriented with the procedures and some of the instructions, but with some teacher clarification all students were able to proceed with the exam. However, many of the students were not prepared or skilled in self-regulation of time – especially in the exam. Students were not familiar with exams where timing of the tasks were fixed. This led to some students finding the pace of instruction/production difficult to estimate and manage.

Most capable students reported the practical nature and ease of online submission of the Portfolio was better than the traditional paper based portfolio. The teacher pointed out that the significant number of the ESL students in his class found the increased cognitive load and the requirement for deconstruction of the web interface language and segmented written task instructions, very difficult to interpret and understand. These ESL students expressed the need for verbal clarification of 'what they had to do' by the teacher as essential for them to proceed with the assessment task.

Great potential for this form of assessment for AIT and other subjects existed, given the high degree to which students were able to engage with the assessment tasks. They need time and

practice before feeling comfortable with this form of assessment. Currently the general cohort opinion was evenly balanced concerning this form of class assessment.

CBAM analysis

The analysis of data from the previous sections are utilised to make judgements about the three constructs of the CBAM:- IC; SoC; and LoU which were employed as diagnostic tools for analysing the implementation of digital forms of assessment for this teacher. The outcomes of these judgements, along with summaries of the evidence supporting them, are provided in Table 6.2. The numbers in the judgement column are from the CBAM IC in Appendix A.

Table 6.2
Judgements for the NA teacher on the CBAM constructs

Construct	Judgement	Evidence
IC		
Access to ICT to support Assessment	(1) Teacher has access ICT for assessment at all times.	Teacher was timetabled into Computer lab for course delivery. He had access to the Internet and opportunities to use ICT for assessments. He indicated that he might explore some quiz or multi-choice types in the future.
Digital Forms of Assessment	(3) Teacher uses no alternative ICT assessments with his course.	Teacher was looking for some form of quiz/multi choice WEB2 testing programs, but did not use computers for assessment purposes. (Q2).
ICT and Pedagogy	(1) Teacher use ICT for most learning activities.	Teacher used some ICT for presentation and for preparation of resources and would like to see his students using computers 100% of the time in AIT.
SoC	(2) Personal	Teacher was concerned with collaborative learning activities from the Internet and students learning computer applications. Although keen to see his students using computers for learning 100% of the time, no tangible evidence of concern towards ICT assessment.
LoU	(3) Mechanical	Teacher indicated he had no plans for integrating ICT into his assessments at present, but was able to implement the assessment task for the study.

Conclusions about attitudes and perceptions of NA Teacher

In this section the discussion summarises CBAM regarding the set of attitudes and perceptions of the NA teacher.

Attitudes and perceptions towards accessing ICT to support assessment

The teacher was highly positive towards ICT and had access to ICT to support assessments. The lab for all his lessons was well equipped and he explored some forms of ICT to support assessments most of the time, such as research on the Internet and electronic journals. The teacher was still in the early stages of using digital forms of assessments; however he was strongly positive towards implementing these forms. He was seeking ICT support to forms of assessment on the Internet which indicated a positive attitude towards supporting the value of ICT in assessments, including digital forms.

Attitudes and perceptions of ICT, course and pedagogy

The teacher was a keen user of ICT for his lesson preparations and teaching resources. He reinforced student learning with ICT by employing on-line learning and collaborative activities in his teaching methods. He was highly positive and believed ICT and pedagogy should be seamless in teaching, and would have liked to see more of his students using ICT in the AIT course, such as using computers 100% of the time in class. Therefore emphasised his positive attitude towards the use of ICT in the course.

Attitudes and perceptions of ICT supporting the AIT exam and portfolio

The teacher was supportive of a computer-based AIT exam being content be part of the introduction of ICT in the exam, though all his students had no computer-based experience previously. He believed ICT was appropriate and had meaningfully engaged students in the exam.

He considered using a digital portfolio to be another positive way of engaging students, because most students were familiar with doing the digital portfolio and could relate to it more.

Conclusions about attitudes and perceptions of the NA Students

In this section the discussion concerns a summary of results from the student survey and forum discussions relating to student attitudes and perceptions of the students.

Attitudes and perceptions towards using ICT

Most students were ESL students; thus they were early users of ICT. Some were positive towards embracing this curriculum mode but most needed guidance and support with ICT.

Attitudes and perceptions towards ICT and learning in the course

Most students believed they could benefit from learning with ICT, comprehending that over time they could learn to appreciate the value in store for their learning. Most students were unable to identify the value of ICT in the AIT course because it was not their preferred option of subject. They were enrolled to suit the school's timetabling process. Some students thought it inappropriate to comment as early users of ICT they were not familiar with it. However for those that had chosen this course, they were relatively positive towards the value of ICT, believing it complemented the course.

Attitudes and perceptions towards ICT supporting the AIT exam and portfolio

Some ESL students took a little longer to become familiar with the concept of completing an exam on a computer; this was their first experience they considered themselves less capable with computer-based exams. Generally those with a incipient ICT skills expressed a keen and positive attitude towards the technology supporting the exam. They felt this exam gave them the opportunity to demonstrate their skills appropriately.

Most of these students were positive towards the portfolio, being familiar with it. Those who had little experience with ICT appreciated the support given by their teacher, helping them to complete the digital portfolio.

Case Study OA: Public School

The OA case study involved one teacher and a class of 24 mixed gender students completing AIT course units 2A-2B which focussed on a web page design.

Implementation, technologies and issues arising

The class was conducted in a computer lab with computers around three walls of the room and some either side of the centre column of the room (Figure 6.3). The students' computers were relatively old but appeared to be adequate for the tasks required of them. Software included MS Office, multimedia and some of the Adobe suite tools. The USB ports needed to be activated prior to the exam. The school's curriculum computer network system was configured with high levels of security access for students. Their logon accounts were mostly protected via firewall settings and students' logon scripts, with limited write access to the school curriculum server.

Figure 6.3 A photo of section of the OA computer room

For the portfolio product the operated a prototype website 'Fashionista' which followed the 'Miss Shoppee' design brief provided by the research team; it was modified in the context of a clothing store website. Some students developed the prototype website using PowerPoint and some used FrontPage. These were exported as HTML or zip file format onto a zipped folder. Students' files were not to exceed 60MB.

Results from data analysis

A range of data was collected and analysed; it included observation of the class, an interview with a group of students, an interview with the teacher, a survey of the students, and the output from their assessment task.

Observations of the class

This class was visited on three occasions to observe students completing the assessment task or to collect qualitative data.

First visit: portfolio product development

The class started well and students settled in smoothly. The researcher addressed the class to explain the assessment task, consent and research; no questions were asked by the students. The final class size on that day was 20 students, the teacher commencing the lesson by passing around booklets of instructions regarding the portfolio assessment and a manila folder for students to keep their work for the portfolio together. This was their first session on the portfolio but they had accessed the MAPS web-based system previously. Hence they were

familiar with uploading and downloading files onto this system. The teacher established the production requirements of the project, reminding the students of the timeline and the importance of following the technology process, as this process was required for the Design Process Document in component two.

Most students worked independently but were allowed to discuss the project with each other. Some students were unsure about the use of owerPoint, particularly how to convert to ZIP, PDF or HTML formats; this was clarified with them. Most students were settled, followed the technology process and typed responses to the main points (Investigate) listed in the booklet given to them. A few interrogated stores' websites and some merely typed up the handout. As a result the teacher put an e-copy of the booklet in their folders.

One girl found a Club Fashionista graphic that she edited; while another not motivated and seeming to be " switched off" and not engaging at all in it.

Second visit: development of process document

The class settled into work; the teacher marked the roll. Students worked on their Fashionista portfolio, some completing while others worked on the timeline. Many students skipped the Investigation stage in favour of the Production phase.

Students were not allowed to zip their files, this being school policy; this was a privilege solely of the teacher. The files must be zipped from PowerPoint, before uploading into the MAPS web-based system.

One student asked about setting up a bulletin board and an email list needed to create this link for their webpage. The email list required creation of a form, but it was an option. All students kept a journal as part of reflective work. Two were comfortable with editing source code within the FrontPage program. They downloaded the source code from the net and applied this to their web page design. All students worked appropriately on their tasks for the duration of the class time. A student was absent for the last session, the teacher explaining that she did produce some work. Classroom rules were clearly displayed written on the whiteboard.

Third visit: examination and student survey

Twenty-one students completed the two-hour practical exam; three were absent. During the first hour they completed a separate theory test, written by the teacher and invigilated by a school representative, as the teacher was away.

It soon became clear that a written 'script' was needed for beginning of exam instructions that is, certain items had to be scripted, like, USBs and headphones However, students were able to use the headphones with some basic help in the initial configuration of the software. Some students didn't know how to activate audio, leaving the mute switch on.

All students logged on with a special 'exam' logon and were able to access resources on the USB thumb drive, but not the Internet – one error message occurring but this was rectified. One student asked whether he should design two posters or two displays; this was clarified. The lack of sound on videos confused three students; this was explained in a later notice. Most students spent ten minutes of Task 1 investigating the resources, because they must choose items most appropriate. It was probably worth having a longer ten-minute reading and viewing time. Three students wanted to know what software to use; they were advised that they could use any of the software programs installed on the machine.

The data file needed to be opened in Excel but then saved as an Excel workbook; at least two students lost graphs because they saved as a text file, even changing the name to charts.xls. Many students didn't understand the appropriate use of file formats and file extensions.

Some students spent much time on e-copies of the planning document, almost producing the product in this document. After 35 minutes into the exam, most students were creating graphs. Two students wanted to complete the feedback form on paper instead of doing it digitally on the computer. They also found that the '.mov files did not play in PowerPoint, so they employed.wmv files. No students were using a website. There was no facility to print as a PDF, a requirement for the exam. After one hour two girl students were reflecting on the format provided but had performed any of the prior tasks.

A few students were asked not to use their school name for this task, this instruction should have been part of prior instuction and should appear in that introduction henceforth

Minor incidents occurred, both positive and negative, such as: four students finished 10 minutes early; One student's PowerPoint froze 5 minutes before the exam's completion but the student had not saved his inputs; and reminders about finishing time had to be given. Two minutes from the end students were reminded to put all work in a submission folder onto the USB thumb drive. They were to zip and upload their submission to the MAPS system. This occurred in a frenzy to be avoided in future. The final upload was reasonably successful with only three students not able to upload their files.

Three students (OA101, OA017 and OA119) were absent; three (OA114, OA115 and OA124) did not upload any files for their portfolio; five (OA103, OA109, OA116, OA120, and OA121) uploaded and attached a journal entry; and thirteen uploaded as an asset but not attached to a journal entry.

On completion of the AIT exam, students were presented with, and completed, a questionnaire. A student forum of 5 students was convened by invitation of the researcher and on a voluntary basis. The group were presented with the same set of structured interview questions with follow-up open response which questions varied according to the structured responses.

Survey of students

Twenty-one students completed the closed and open items in the survey. The results of analysis of each item for this case are discussed in this section. A summary of results from the descriptive statistics for the closed items is listed in Appendix K.

Closed items

For item Ea, sixteen students indicated they had little experience completing an exam or test using a computer before, one student (OA114) he had never done any exams or tests on computers but needed little time in becoming familiar (E1b). Four students (OA102, OA113, OA115 and OA120) avowed they needed to become familiarised E1b). Student OA106 did not respond to either E1a or E1b. The effect sizes for both questions were relatively small, -0.29 and -0.28, which implied the student cohort was similar to the population sample for E1 items.

For E2 items, most students showed the exam to be simple and useful. There were two exceptions, student OA102 strongly disagreed that it was easy to follow the steps for the exam on the computer; however he was able to demonstrate some relevant skills in the exam (E2g and E2j). Student OA116 strongly disagreed that it was easy to follow the steps of the exam on the computer (E2g). Absolute values for item mean difference effect sizes were between 0.04 and 0.7, predicting this would be less positive towards following the steps of the exam on a computer. Perhaps they were less skilled in completing a computer-based exam being new to this format. However, the group as a whole were not significantly different using computers in this factor to that of the population.

For items P1a, b, the majority of students denoted they had completed a portfolio on a computer previously but needed some time to become completely familiar. The class mean for P1a was 2.95, which was above the population mean but, having an effect size of 0.40, pointed to them being only a little less experienced in computer use when completing the AIT portfolio than the population.

For all P2 items listed, most students agreed it was easy and useful doing the AIT portfolio using computers with the exception of two students (OA102 and OA116) who were less positive about the matter of using computers to complete their portfolios (P2g and P2j). Item absolute effect sizes were between 0 and 0.4 affirming them to be similar to the population in this instance.

For Q5 items, students generally used at least seven out of eight technologies listed, ranging from computer to webcam at home. Six students agreed they used all the technologies listed, Students OA101 used a laptop, and OA113 only used an MP3 player at home. The class mean for all Q5 items was above the population mean and the effect sizes ranged from 0.11 to 0.50 which indicated more students in this phase of the research used the range of devices listed in Q5. However effect sizes indicated that they were as similar to the population in the use of computer technology at home.

For Q6, a large majority of students declared they have access to Broadband Internet OA101 being the exception in having dial-up Internet at home. Effect size for Q6 was 0.33 showing the group was not significantly different to the population with type of Internet access at home.

For Q7, most students declared their use of a computer at home on most days. Two, (OA114and OA117, told they rarely use a computer at home. Effect size for Q7 was 0.34 signifying the cohort was similar to the population for this question with regard to the frequency of computer usage at home.

For Q8 items, most students in this class calculated they spent approximately 114 minutes on average each day using computers at school. Student OA118 was the exception indicating he spent 360 minutes on a Wednesday using a computer at school, while OA111 only used the computer on a Friday for 30 minutes. The mean for this class was above that of the population, with an effect size of 0.51 pointing out that on average they spent somewhat more time on computer applications at school than the population.

For Q9, twelve students observed they touch typed using all fingers, and nine students did not touch type using all fingers. The effect size was 0.46, which indicated some difference to the population, with fewer students touch-typing.

For Q10 items most students revealed they applied all items listed. However, eleven students indicated they did not keep a list of addresses of friends (Q10a), and eight students denoted they did not draw a diagram or picture (Q10b). An effect size of 0.03 showed there were no significant differences to that of the population for Q10 items.

For Q11 items most respondents showed a positive attitude towards using computers. One student (OA105) confessed to not enjoying computer use at school (Q11b), and one student (OA104) indicated that he did not care to use a computer at home to complete school work. All students appreciated discovering matters for themselves instead didactic teaching (Q11d). Most students were positive about and believed that computers were good for the world (Q11e). The class mean for Q11 items were close to the population mean. Item mean difference absolute effect sizes were 0.2 and 0.4 pointing out these students to be as positive towards using ICT to support assessment as the population.

For Q12 items, the majority of the cohort were confident in using computers, with the exception of two students (OA120 and OA115), who were less confident about attempting a new problem using the computer (12c) and could not learn to program a computer. The class mean for all Q12 items was relatively close to that of the population. Item mean difference absolute effect sizes ranged from 0.1 to 0.6 indicating these students to be similar to the population in their computer use. The larger effect size of -0.6 for item Q12d revealed them to be less confident then the population and feeling they did not do well with computers generally.

For Q13 items, most students showed a high level of skill in using most of the software listed. Two students (OA107 and OA116) admitted they could not understand Spread-sheets (Q13b), one who OA106 avoided Databases (Q13c), one indicating webpage authoring to be beyond his talents (Q13h), and two (OA107 and OA109) were not confident enough to attempt Video editing (13k). The class mean for most of Q13 items was below the population mean, except for Databases with a mean of 2.90. However effect sizes range from -0.04 to -0.31 indicating these students' self-assessment of ICT skills was similar to that of the population.

Open-ended items

Students responded to two open response items concerning the two best and worst experiences about the exam and the digital portfolio. A summary of responses is given in Appendices P, Q, R and S.

Generally for their two best experiences during the AIT exam in the computer lab were considered to be ease of use ability to complete the exam more quickly. One student (OA104) indicated that he was able to develop his ideas better, and another (OA112) was able to create designs and utilise a variety of content/templates. Student OA107 indicated it was a faster way to put his designs into the final documents. OA students' responses such as "no need to write" and "less hand cramps" were common. For the two worst things when completing the AIT exam in the computer lab, students showed their concern about: difficulty of sketching on a computer (OA101), lack of reliability (OA102), difficulty in using some of the software (OA111) and insufficient time to design properly (OA112).

Generally the two best things in completing the AIT portfolio, were considered to be easy of application and appropriateness of the course. Student OA101 indicated completion of the AIT portfolio using a computer saves time and student OA112 approved because the course was applied IT so better using the computer. The two worst things about computer use for AIT portfolio drew only six responses. Students considered the process to be long (OA101), achieving a lesser quality result than if completed on paper, and one (OA109) complained annoyance at putting everything in the folder.

Questionnaire scales

This section presents the seven scales that were derived from combining items from the questionnaire. Results are shown in Table 6.3 and Figure 6.4 below. Then the results for each scale are discussed separately.

Table 6.3
Descriptive statistics for the student survey scales for the OA class

| Scale	OA Class					Population		Sample
	N	Min	Max	Mean	SD	Mean	SD	Effect Size
eAssess	21	2.10	3.27	2.80	0.34	3.03	0.50	-0.46
eAssessP	21	2.27	3.91	3.08	0.37	3.19	0.63	-0.17
Apply	21	1.83	2.83	2.38	0.26	2.39	0.38	-0.03
Attitude	21	2.00	3.00	2.65	0.26	2.63	0.30	0.07
Confidence	21	2.33	3.00	2.80	0.15	2.77	0.27	0.11
Skills	21	2.09	4.00	3.20	0.52	3.33	0.55	-0.24
SCUse	21	6.00	270	114	74	79	69	0.51
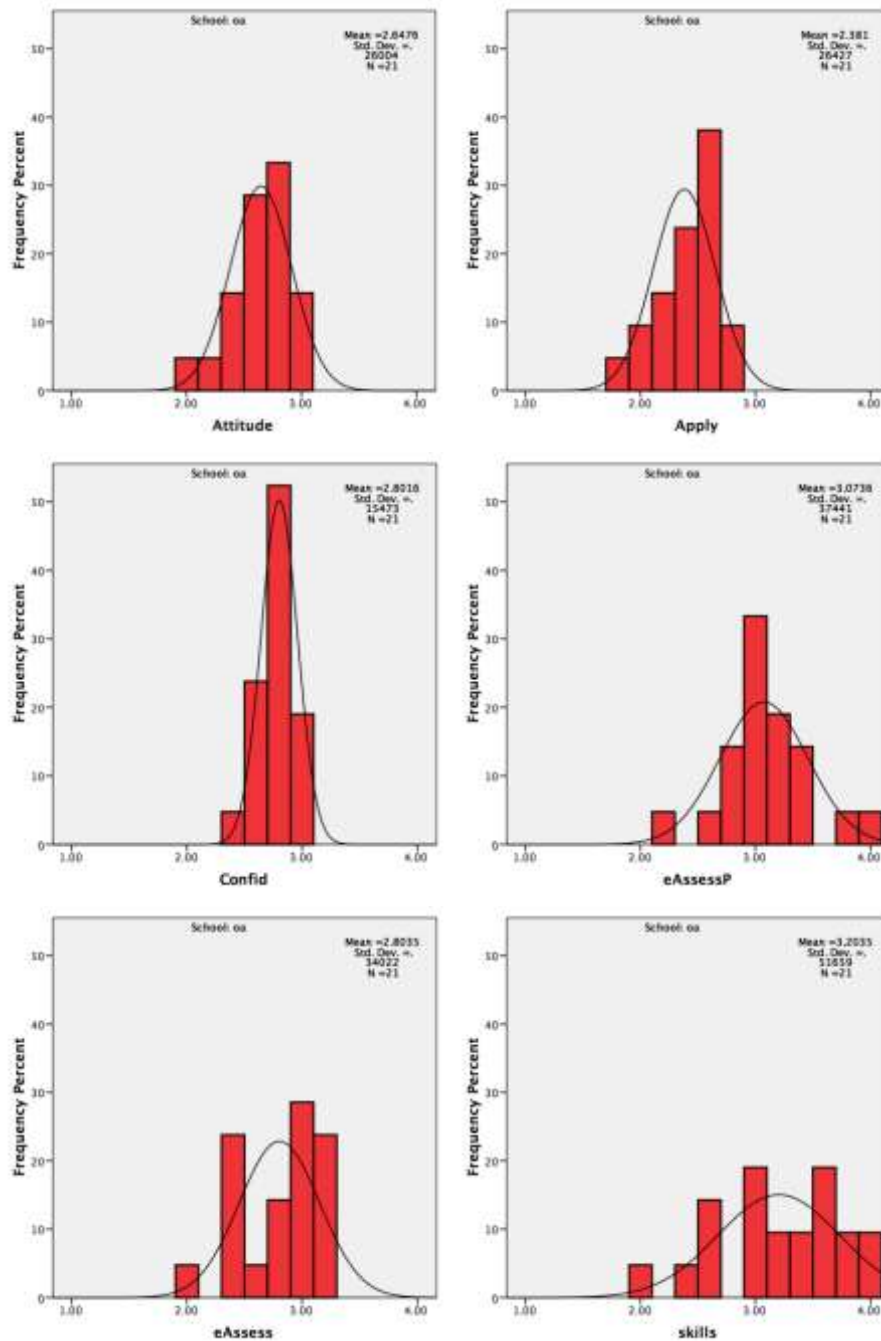
Figure 6.4 Distribution of scores for the student survey scales for the OA class

The eAssess graph showed most students clustered around 3.00. A relatively large group of students clustered below the 2.50 scores. The class mean was slightly below that of the population, a less spread group of students between the 2.50 to 3.50 range of scores. An effect size of -0.46 indicated that on average this class perceived themselves as having a little less efficacy than the population regarding the value of the computer-based exam.

The eAssessP graph revealed most students to score above the midpoint 2.50, with a small numbers of students in the top 4.00 scale of the graph. The average was slightly higher than for the population. However an effect size of -0.17 showing that on average no significant difference from the population regarding the efficacy of the AIT portfolio.

The Apply graph showed little spread with most students' scores being between 2.50 and 2.80, the remaining students being spread across the lower section of the graph. An effect size of 0.03 signified this class was as likely as the population to apply of computers to various uses listed in Q10 items.

The Attitude graph showed little spread with most students' scores being in the range 2.50 and 3.00. The cohort mean of 2.65 was slightly higher than the population mean with little spread (SD 0.32), and an effect size of -0.07 indicating this class to be similar to the population in having a positive attitude towards using computers for items listed in Q11.

The Confidence graph affirmed there to be most students clustering around the 3.00 scale. The class mean was 2.80 and SD was 0.15 showing little spread within this group. An effect size of -0.26 revealed them to be confident in using computers, but not significantly different to the attitude of the population for Q12 items.

The Skills graph was positively skewed with a class mean of 3.3 and SD of 0.30, most students clustering above 3.00; this portends this class's self-assessment of their ICT skills to be positive. However an effect size of -0.24 showed this research group to be similar to that of the population concerning self-assessment of ICT skills.

The SCUse graph revealed a large spread amongst this class in the amount of time spent daily of 0-360 minutes (OA117 spent 360 minutes every Wednesday) using computers at school. Most students averaged 114 minutes on any one-day using the computer. However an effect size of 0.51 showed a large number of students to spend more time per day using using computers at school than was typical for the population.

OA AIT students' forum

A small group of students was selected by the researcher to be interviewed as class representatives immediately after the AIT examination. The focus was on making comparisons between the AIT portfolio and the exam. The forum students gathered, sitting in a semi-circle in a classroom. The following is a summary of the interview, the actual student questionnaire responses appear as Appendix E.

The forum representatives told of their satisfaction in completing the portfolio; it was very similar to their usual class work. They expressed some concern about the exam, as they had not completed such a computer exam before. They commented on the wording, saying it was too complex and difficult to understand. They needed more time to view materials and read at the outset, and it was unclear how the steps were sequenced. They preferred there to have a practice exam before the actual exam; this would enable them to practice attempting a similar exam on a computer. They believed too many tasks were included in the exam and they were not familiar with spreadsheets.

They were satisfied with the portfolio, commenting on being able to showcase their best quality work with the aid of computers, particularly PowerPoint. Overall students agreed it to be faster typing than writing during the exam, and that all assessments should be similar.

Pre-Interview with the OA Teacher

The teacher provided feedback by way of an email return to a set of questions prior to her class being involved in the assessments (Appendix G). The following is a summary of responses to the questions.

The teacher commented on her students use of computers for assessment purposes. Students employed computers for completing tasks/assignments, researching on the Internet using Google, the software used including Inspiration, Photoshop, Publisher, Word, Excel and PowerPoint. Students used PowerPoint presentations with overhead projector/s; but she would prefer the students to employ computers during all four periods a week. Her teaching method during classroom discussions allowed students to type and save notes on their computers.

The teacher believed the strength of using computers for assessment was important in both practical and theoretical work as it provides students with a range of skills which enables them to perform well. The weakness in using computers for assessment occurred because not all schools have a permanent computer room nor allocated sufficient staff during examination periods. However, this weakness could be overcome through discussions with the Head of Department and the Principal. She is currently looking for more exemplars of using computers for assessment from other schools while developing and improving the delivery of the course at her school. She considered the effects of using computers for assessment should be flexible due to the different arrangements at other schools; however at the moment she does not foresee any major issues using computers for assessment in her program. Her

teaching methods will always endeavour to vary her tasks/assessments in order to maintain her students's motivation. Although she is not currently working with other staff on the use of computers for assessment; she is willing to test other solutions which can be integrated into the school plan and timetable.

Post-interview with the OA teacher

The teacher provided feedback by way of an email return to a questionnaire administered after her class completed the assessments. (Appendix J). The following is a summary of responses to the questions.

The teacher commented that the AIT assessment tasks provided students with an opportunity to use current skills and learn new skills. They spent most of their time producing their solution but the teacher felt the students had difficulty understanding the task due to use vocabulary used in the assessment tasks. Much one-to-one assistance was required, hence more time was taken in this class for the AIT assessment tasks.

The teacher recalled she had to motivate students constantly to ensure they submitted their AIT portfolio on time, saying more time could be added for completion of the product. She added that her students were visual learners which resulted in examples being given on the overhead projector so as to present the students with an idea exemplifying what was needed for the tasks. She found both male and female students interested in producing a clothing website.

Students' feedback regarding the AIT exam indicated it was too long, some being unable to complete the test. They showed a preference for being able to complete classroom-based assessments. This lady teacher concluded there was a definite potential for AIT, and other subjects, to have computer-based exams which may require trials and adjustments to the examining methodology.

CBAM analysis

The results of the analysis of data from the previous sections were employed to make judgements for the three constructs of the CBAM-: Innovation Configuration (IC); Stages of Concern (SoC); and Levels of Use (LoU). This instrument was employed as a diagnostic tool for analysing the implementation of digital forms of assessment in this study. The outcomes of these judgements along with summaries of the evidence supporting them are provided in Table 6.4. The numbers in the judgement column are from the CBAM IC in Appendix A.

Table 6.4

Judgements for the OA teacher on the CBAM constructs

Construct	Judgement	Evidence
IC Access to ICT to support Assessment	(1) Teacher has access ICT for assessment at all times.	Teacher was timetabled into a computer lab and had access to ICT for assessment. She did not see any major issues using ICT with her assessments.
Digital Forms of Assessment	(2) Teacher may use one form of digital assessment with her course.	Teacher used some form/software packages, which contained basic graphical representations. She said in the initial interview that she had used computers for assessments.
ICT and Pedagogy	(1) Teacher use ICT for most learning activities.	Teacher used PowerPoint and overhead projections for presentation and for preparation of resources; she would have liked to see her students (note taking) using computers every lesson in the AIT course.
SoC	(3) Management	Teacher sought to improve the delivery of assessment in the AIT course at the school by sourcing more exemplars from other schools. She is willing to try options.
LoU	(3) Mechanical	Teacher indicated that she was willing to test other assessments/solutions and was prepared to integrate ICT assessments into the school plan.

Conclusions about attitudes and perceptions of the OA teacher

This section discusses the summary of CBAM judgements concerning of attitudes and perceptions of the OA teacher.

Attitudes and Perceptions towards accessing ICT to support assessment

The teacher had access to a computer lab for all her lessons believing ICT used with her students assisted them in developing a range of skills for AIT assessments. She employed several forms of graphical packages in the assessments and evaluation of student work; however she was at the early stages of implementing digital forms in her assessments. She supported digital forms of assessments positively by collaborating with other schools interested in digital forms.

Attitudes and perceptions of ICT course and pedagogy

This teacher affirmed the ICT pedagogy would enhance student learning because her students had responded well in a visual environment. She motivated her students by deploying an overhead projector and Internet websites as a means of adding value to her teaching. The teacher was cautious in the uptake of ICT in the AIT course, contending the strength of computers use would be important, but some teachers did not have appropriate ICT skills or were receptive to ICT. She agreed to be of assistance with future research into the use of ICT in support assessment in AIT courses. She had a strongly positive attitude towards the employment of ICT in future AIT courses.

Attitudes and perceptions of ICT supporting the AIT exam and the digital portfolio

This teacher was positive the ICT exam, affirming students to have sufficient ICT skills to demonstrate their abilities in a computer-based exam. A small number of students lacked ICT vocabulary skills applied in the exam, which meant it took a little longer to complete. However, overall she recognised the potential for ICT to support of the exam.

She declared the digital portfolio to be more favoured by her students, and was marginally more positive towards accepting the value of the digital portfolio at this stage. She spent more time motivating her students with the digital portfolio.

Conclusions about attitudes and perceptions of the OA students

This section's the discussion concentrates on the summary of results from the student survey and forum discussion regarding the attitudes and perceptions of the students.

Attitudes and perceptions towards using ICT

The students were familiar with ICT as indicated by the student results in (Q5), most of them having access to a range of ICT devices, and connected to the Internet via broadband. Most used ICT on a daily basis at school and at home, being comfortable and positive towards the use of ICT.

Attitudes and perceptions towards ICT and learning in the course

The students asserted ICT was part of their learning; they were not daunted by it; realised it was of assistance to them; and welcomed the learning presented in this manner. Having been

brought up in the digital era they were highly positive about ICT supporting learning. The students used computers on a daily basis, believing that ICT should be part of the course; they tended to allow the deployment of technology as important in the preparation for the future. This perception was inferred from the open items comments concerning ICT's application, such as: '... *able to use technology in Applied Technology course* and *... more reflective of our tasks and classwork' (OA).* They chose the course that used IT, tending to believe computers were 'good' for the world.

Attitudes and perceptions towards ICT supporting the AIT exam and portfolio

Generally, the students were happy with the AIT exam, asserting the exam was straight forward and they were able to complete the exam more rapidly with ICT support; his helped in developing their ideas with a variety of templates stored in the computer ready to be operated. It was also easier to change or edit and finalised documents. Although some of them took longer to become familiar with the concept of taking the exam on a computer, as this was the first experience for them. Most students were able to show their ability in the format of the exam was implemented. They were marginally positive towards a computer-based exam compared to the population.

Most students were more familiar with the digital portfolio compared to the AIT exam. They had previously submitted their work in a portfolio environment, encouraged by their teacher. Clearly they were highly positive towards the digital portfolio.

Case Study VA: Public School

The VA case study involved one teacher and a class of 20 mixed gender students completing the AIT course Units 2A-2B, focusing on a web page design. The school did not offer the Computer Science course, but the teacher believed a group of boys were were ready to study Computer Science, as they were not interested in the media side of AIT.

Implementation, technologies and issues arising

The class was conducted in a computer lab of Apple Macintosh computers less than three years old and well equipped with MS office and multimedia software. The computers were spaced around three walls of the room (see Figure 6.5). The school's curriculum computer network system was configured with high levels of security access for students, their logon

accounts being mostly protected via firewall settings and students' logon scripts, and having limited write access to the school curriculum server.

Figure 6.5 A photo of part of the VA computer room

For the portfolio product the students worked on a prototype website, 'Miss Shoppee' design brief provided by the research team. The teacher followed the design brief exactly as intended, including the portfolio and the examination as part of the semester mark awarded. Students worked on the Production phase, executing their planning on templates provided by the teacher. These templates formed the basis for the storyboarding and design processes required for the Design Process Document in component two. Most students worked independently but they were allowed to discuss with each other elements of their project.

Results from data analysis

A range of data was collected and analysed, including observation of the class, an interview with a group of students, an interview with the teacher, and a survey of the students. The results of analysis of each of these sources of data are discussed seriatum. At the conclusion, a summary based on all sources of data is provided as a CBAM analysis and conclusions.

Observations of the class

This class was visited on three occasions by the researcher or one of his assistants to observe students completing the assessment task or to collect qualitative data.

First visit: portfolio product development

The researcher was introduced, gave a brief introduction to the project and consent forms handed out. One AIT class was implemented during the current year at Year 11 level, and two

for Year 12 students, some of whom did not want to be involved in the research project as they were more interested in the Computer Science course.

On this visit students had completed a logo and were working on a poster, most of them were using Photoshop, some employed Word.

Second visit: development of process document

Students entered the class room, starting immediately into working on the website production. Most students deployed Dreamweaver; one student used iWeb. The teacher remarked that they learned how to use Dreamweaver in Year 10. Because one boy used Dreamweaver at home and at school so he was able to program using the source code. All students were working on the production phase, some sourcing material such as images copied off websites.

A wide variety of designs emanated from within this class, indicating some copying of each other's ideas. Photoshop and Flash were employed to create content for the product advertisements on the website. Some used Google Maps to include a 'store location' in their production

Two students used storyboards from the template supplied by the teacher. One boy had developed four storyboards, selecting one to develop as a web page. The teacher related how students had started their storyboard but after one session rarely finished it. One boy used iMovie to create an advert for his website. The cohort used the Education Department's online learning and teaching system known as OLTS at home while working on their AIT portfolio.

Third visit: testing iMac lab and USB flash drive connectivity

The school's computers in this lab were tested with a sample USB flash drive. No issues emerged with the interfacing and deployment of computer applications via the USB port connection with these computers.

Fourth visit: examination and student survey

Twenty students completed the two-hour practical exam. The lab was equipped with iMac computers, the space in this lab being over-crowded with its complement of students. Student VA108 had no files on her USB flash drive at the commencement of the exam so she was given another USB flash drive promptly and proceeded with the exam. One student asked, 'can we create a website for an interactive display for the advertisement?' At the start of the exam one computer crashed the student was moved to another computer without any loss of

work time. Most students planned on paper, one inquiring whether his plan for an interactive display could include all screens. Several students were still reading and browsing five minutes after reading time, thus emphasising the necessity for organisers to reconsider time allotted during the exercise.

This research group had no problem opening the file data.txt with Excel on a Macintosh computer, perhaps the Mac OS version of Excel was more user-friendly than its Windows' version. Students pointed out that one section of the exam instructions indicated one video or one audio, while elsewhere the instructions indicated a video and one audio. This was a mistake in the instructions and was corrected in the exam document and noted.

The students in this class seemed very comfortable when using Excel; hence they spent more time than they should on the charting exercise.

Survey of students

Twenty students from this class completed the closed questions and open items of the questionnaire. The results of analysis of each item for this case are discussed in this section. A summary of descriptive statistics for the closed items are listed in Appendix K.

Closed items

For item E1a, thirteen students agreed they had no experience completing an exam or test on a computer before. Two students (VA102 and VA111) replied they had no experience and did not require more time for familiarisation (E1b). Student VA115 did not respond to either item. Item mean absolute difference effect sizes were between 0.2 and 0.4, this class was as inexperienced in applying computers in the exam as the population.

For E2 items, the majority of respondents commented on the ease with which he exam was completed using a computer. The one exception was VA115 who disputed strongly most E2 items (E2a, b, d, e, f, i, j and k), contending the content prevented the display of his skills in the exam. Item mean absolute difference effect sizes were between of 0.01 and 0.36, showing this class was not significantly different to that of the population.

For items P1a and b, most students agreed they had achieved small small computerisd portfolios but are still in need of familiarisation time. Student VA103 indicated he had experience with portfolios and did not require more time. On the contrary, VA108 pleaded he had no proper portfolio time, hence requiring teaching completely. Item mean absolute

difference effect sizes were between 0 and 0.19, demonstrating that these students were similar in standard to the population.

For all P2 items, the cohort thought computers were easy to use and supported completing the AIT portfolio. One student (VA104) enthused and was very positive about all the items listed in P2. Another (VA105) did not respond to any P2 items. The students being investigate believed the computers aided them in the completion of their AIT portfolios. The class means for P2 items ranged from 1.60 to 2.80 and effect sizes were from -00.1 to 0.40; thus on average the responses of this cohort were similar to the population with regard to completing their portfolios.

For Q5 items, eight students, (VA101, VA102, VA109, VA111, VA113, VA117, VA117 and VA120) used all of the items listed, ranging from computer at school to webcam at home. Another six indicated they used most of the items listed. Three students, (OA105, VA112 and VA116), did not respond to Q5 items. Most students used at least four of the range of technologies listed. Item mean absolute difference effect sizes were between 0 and 0.64. Although they were not as familiar with webcam, the use for this device was less necessary in this course design. No importance was apparent to make the students different to the population in the use of computer technology at home.

For Q6, fourteen respondents in this class had access to broadband Internet at home, with the exception of two students (VA103 and VA114) who used dial-up Internet. Three students (VA105, VA112 and VA115) did not respond to Q6. Student VA116 indicated that he did not have Internet access at home. However mean difference effect size was -0.29 showing this study group to be not significantly different to the population with the type of Internet access at home.

For Q7, most students used a computer at home most days. Four students (VA104, VA105, VA112 and VA115) did not respond to Q7. Effect size for Q7 was -0.13 revealing they were similar to the population with regard to the frequency of computer usage at home.

For Q8 items, most students spent approximately 75 minutes on average each day using computers at school. Student VA115 was the exception, revealing he employed a computer for 360 minutes each day at school. Five students (VA105, VA106, VA107, VA109 and VA112) indicated zero usage. The class mean was below the population mean with a significant variability in computer usage, namely from no time to over 360 minutes. Item

mean absolute difference effect sizes were between values of 0.01and 0.23 a similarity with the population which computers at school.

For Q9, twelve students touch typed using all fingers, two did not touch type at all, and six students gave no response. An effect size of -0.22 indicated there to be no significant difference with that of the population.

For Q10 items, most students used a computer to perform most of the tasks listed. Except for Q10a and b, wherein they did not use a computer to keep a list of addresses of friends to draw diagrams or pictures. The class mean for Q10 was below that of the population: however item mean absolute difference effect sizes of absolute values between 0.1 and 0.4 indicated there to be no significant difference with the usage of the various computer software applications listed.

For Q11 items, the majorityof research respondents considered computers to be good for the world. In their positivity they believed computers made schoolwork much easier. Item mean absolute differences were between 0.15 and 0.29, showing these students were as positive as the population.

For Q12 items, students were generally confident in using computers, with some exceptions particularly to Q12e wherein two students (VA113 and VA118) professed to not being able to learn to program a computer. Item mean absolute difference effect sizes were between 0.1 and 0.4, denoting these students to be similar in confidence to the population in using computers.

For Q13 items, most students indicated they possesssed a high level of skill in using most of the items listed; the exception was Q13k concerning authoring and editing respectively. Four students (VA105, VA106, VA112 and VA115) provided no response to Q13 items. Item mean absolute difference effect sizes were between -0.04 and -0.43, showing these students' self-assessment of ICT skills was relatively similar to that of the population.

Open-ended items

Students answered two open response giving their opinion of the two best and worst things about the exam. A summary of responses is given in Appendix J.

Generally, the two best things concerning the AIT exam it was easy to change design ideas and it was less stressful. Students expained it to be a practical and simple to design the product. The exam was satisfactory in that they were able to get their ideas across relating to the practical AIT course and was easy to make corrections when needed. The two worst

things about doing the AIT exam in computer lab, most students were found to be unhappy with computers lagging and freezing when they performed a task. Some students were concerned with the lack of time allocated for the duration of the exam and a few found it difficult to understand some questions.

Generally for the two best things about undertaking the AIT portfolio, students considered it was easier to undertake, and less hassle and ease of setup. The two worst things regarding the AIT portfolio were concerned with the added workload and the process of uploading the portfolio. Students made comments about becoming more familiar with the portfolio.

Questionnaire scales

This section presents the seven scales derived from a combination of items from the questionnaire. The results, each of which is discussed separately, are shown in Table 6.5 and Figure 6.6.

Table 0.1
Descriptive statistics for the student survey scales for the VA class

| Scale | VA Class | | | | | Population | | Sample |
	N	Min	Max	Mean	SD	Mean	SD	Effect Size
eAssess	20	1.36	4.00	3.05	0.51	3.03	0.50	0.04
eAssessP	20	1.82	5.00	2.89	0.54	3.19	0.63	-0.48
Apply	17	1.67	3.00	2.30	0.41	2.39	0.38	-0.24
Attitude	16	2.00	3.00	2.54	0.30	2.63	0.30	-0.30
Confidence	16	2.00	3.00	2.76	0.28	2.77	0.27	-0.04
Skills	16	2.45	4.00	3.24	0.47	3.33	0.55	-0.16
SCUse	20	0.00	360	75	87	79	69	-0.06
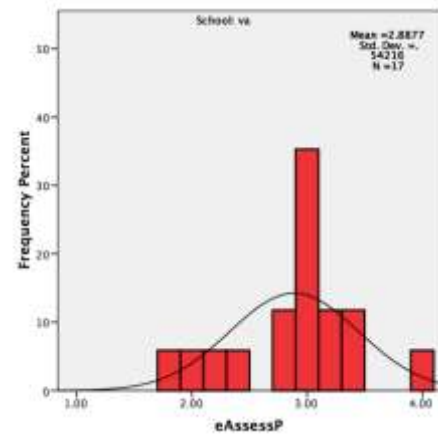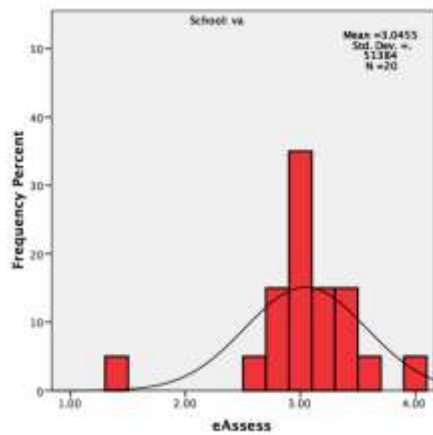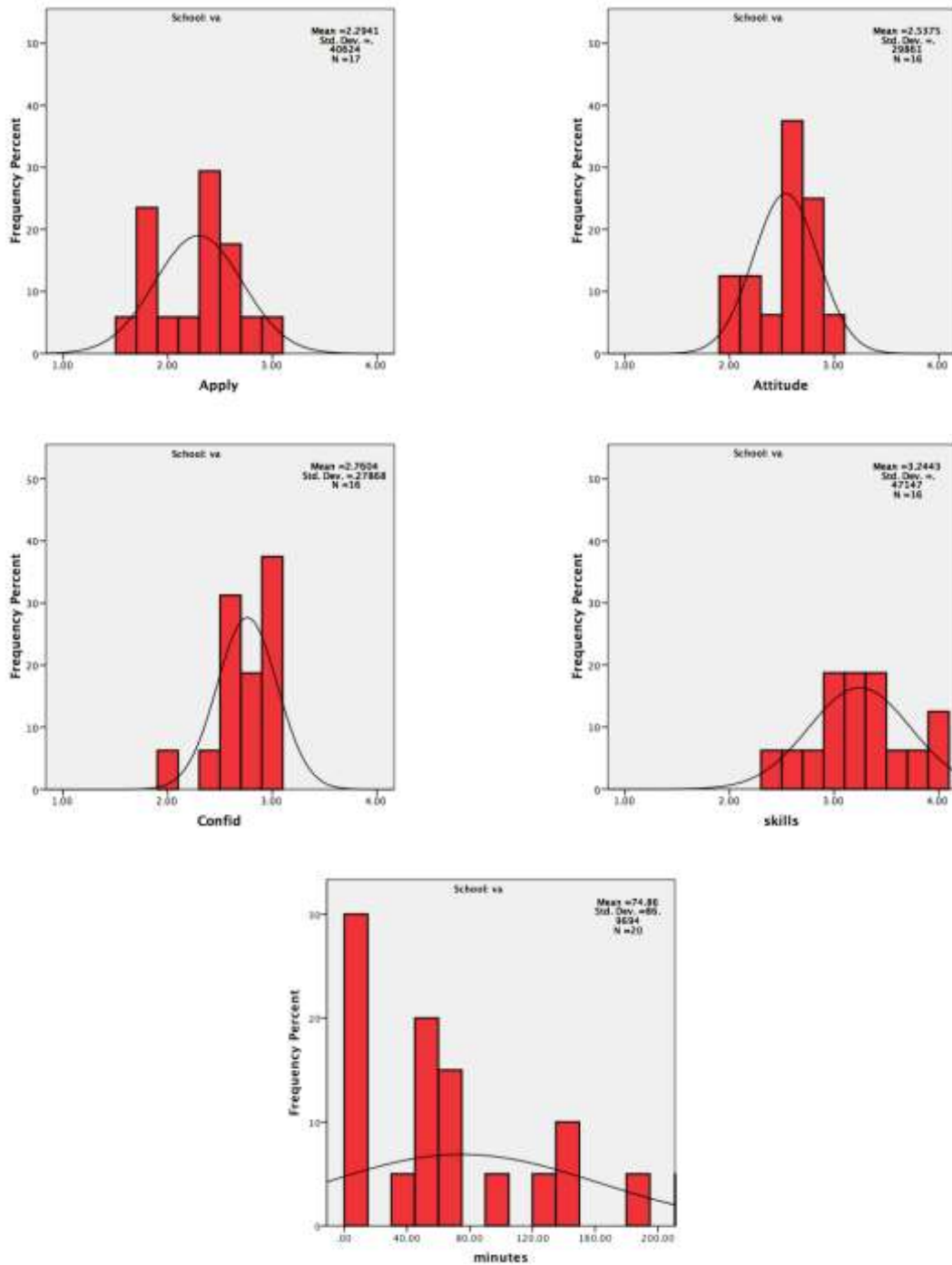
Figure 6.6 Distribution of scores for the student survey scales for the VA class

The eAssess graph depicts most students' scores cluster around 3.00 or above on the scale. A small number of students were to be found at both extremes of the scale. The mean for eAssess was slightly above the population mean with a similar spread (SD 0.51). An effect size of 0.04 showed the mean for this class was not significantly different from that of the population.

The eAssessP graph shows most students' scores to aggregate around 3.00 with a small number of students topping 4.00 on the scale. The mean for eAssessP was below the population with a smaller spread. An effect size of -0.48 indicated this class perceived a little lower efficacy for using computers in the portfolios compared with the population.

The Apply graph shows a good spread amongst the respondents with slightly larger number of students being above the 2.50 score. The class mean was slightly below the population mean, indicating this class was similar to the population in their use of computer applications listed in Q10. However an effect size of -0.24 showed this class to be similar to the population.

Attitude had a class mean of 2.54 with a standard deviation of 0.30 skewed positively. the students had displayed a positive attitude towards using computers as represented in the Q11 items. The graph indicated most students were in the range between 2.50 and 3.00; thus the class mean was slightly below to that of the population mean, 2.63. An effect size of -0.30 evidenced that this class was similarly positive in attitude as the population.

The Confidence graph depicts a large number of students clustering between the 2.80 and 3.00 scores, with a mean of 2.8 being close to the population mean. An effect size of -0.04 indicated they were confident but not more confident than the population for Q12 items.

The Skills graph pictures a shows good spread, with a class mean of 3.24, slightly lower than that of the population, 3.33. Most students in this class pointed out they possessed most of the skills needed for E13 items. In this matter, an effect size of -0.16 indicated they were similar to the population.

The SCUse graph indicates a large variability of students in this class regarding the time spent daily employing a computer at school (Q8 items). More students than average did not use computers on a given day at school (0 minutes). Students' computer usage varied from zero to 360 minutes a day in this class. An effect size of -0.06 indicated the study cohort to be similar to the population with computer usage at school.

VA AIT students forum

The forum students gathered and sat for discussion in a semi-circle in a classroom. A transcript of their deliberations is included in Appendix E.

The students explained being satisfied with the the exam and they liked it because it was a practical exam and the AIT course was a practical course. It was easy to show their work visually as the portfolio and the exam were very similar to their usual class work. They

commented on the ease of creating interactive folders on a computer, commenting that writing for them would be too slow and preferring to type into a computer. They were able to do their best quality work and the computer assisted them to display their computer and software abilities. They felt that the exam implemented in its current form was a big improvement for a practical course, being more relevant to the program.

Some concern was expressed about procedure as they had not entered upon such a computerised exam before. Forum members commented that the wording of the exam was too complex and difficult to understand. More time should be allocated for first section of the exam. At the outset it was not clear how the steps were sequenced, which necessitated more reading time. Some concern was expressed about malfuntioning hardware with students losing work and time during the exam. A practice exam and more time allocated were recommendations for the future. Otherwise there were not many suggestions for changes.

Pre-interview with the VA teacher

The teacher provided feedback by way of an email return to an e-mail questionnaire prior to her class being involved in the assessments (Appendix G). The following is a summary of her responses to the interview questions.

The teacher indicated her students used computers for assessment regularly, apart from exams. They researched, wrote reports and created projects including websites, animations and documents. She would have liked them to use computers 95% of the time in her lessons with the other 5% for their in-group discussions. Her students had access to their textbooks on the computers.

She did not see any weakness in using computers for assessment except for brainstorming because her students needed to be closely monitored to ensure they stayed on task. She monitored by having them to accept some responsibility for their use of the school computers.

The teacher was not seeking any information about using computers for assessment except for this research study. She used computers for assessment in her teaching program to ensure learning more applicable to the AIT course. She intended to use computers for assessment in the near future, intimating she unsure how she would work with other staff in this matter as there was maintenance needed on the school's servers. She evinced a positive attitude towards using computers for assessment, believing this to be the manner in which AIT should be

examined. Her hope was that all practical subjects would use computers for assessment in future exams.

Post-interview with the VA teacher

The teacher provided feedback by way of an email return to a questionnaire protocol after her class completed the assessments (see Appendix J). The following is a summary of responses to the questions.

The teacher commented on being very impressed with the assessment tasks which covered the required content of the AIT course of study. She agreed with the process document as it was informative, well structured and student friendly. Her students enjoyed creating the product, finding the process document different, but once they started working on the assessment tasks most students really appreciated it. This teacher remarked that all the students enjoyed the tasks and looked forward to the exam; therefore she would like to think this procedure was the way forward for AIT courses.

She was a little disappointed in students' work, considering they could have performed better. Students had difficulty in applying the design elements and principles, so she may need to concentrate on these aspects more in the future. They may have produced better work also if they kept referring back to the design brief. The more technical students were not really enthusiastic about documenting the investigation process, preferring not to document for the Technology process. On the whole students were very positive towards the whole process after initial hesitation because they were reticent about having others view their work; they thought this might lead to them having to undertake extra work. Two students were concerned with their ability to use the software and this hindered them a little. Two students struggled with the product as they had little prior knowledge of computing or using Macs. However, on the whole, all respondents really enjoyed the tasks. Generally the school's computer system had not functioned satisfactorily well during this year with the computers and server crashing, and students not being able to log on for a period of two weeks. At the time of the research the computers were still not running at their optimum. Upgrading to the latest Office software at the end of term 3 was a little disconcerting for some students.

The teacher agreed there to be some issues with the timing of the exam, some students being on overseas holidays. Various camps and excursions, not on the calendar at the beginning of

the year or semester upset forward plans, while incidental assemblies and guests speakers were disruptive to time tables also.

The teacher felt the need to meet with teachers from other schools attempting this type of assessment so as to gain an understanding of their interpretation of the assessment, and enjoyed brainstorming with them on the whole process. She saw the necessity for more practice exams with students so they would be completely comfortable with the exam process.

CBAM analysis

The results of the analysis of data from the previous sections were combined in order to make judgements about the three constructs of the CBAM:- IC; SoC; LoUemployed as a diagnostic tool for analysing the implementation of digital forms of assessment for this teacher. The outcomes of these judgements, along with summaries of the evidence supporting them, are provided in Table 6.6. The numbers in the judgement column are from the CBAM IC in Appendix A.

Table 6.6
Judgments for the VA teacher on the CBAM constructs

Construct	Judgement	Evidence
IC		
Access to ICT to support Assessment	(1) Teacher has access to ICT for assessment at all times.	Teacher was timetabled into a computer lab with Apple Macs. She had access ICT for assessments, but had not used ICT supported assessments.
Digital Forms of Assessment	(2) Teacher may use one form of digital of assessments with her course.	Teacher used variety of digital forms for research, reports and including websites, animations for assessments in her class.
ICT and Pedagogy	(1) Teacher uses ICT for most learning activities	Teacher indicated that her students used computers and liked lessons with the support of ICT around 95% of the time. Her students had access to textbooks on computers in the lab.
SoC	(4) Consequence	Teacher believed that using ICT to support assessment made learning more applicable to the AIT course. Her focus was mainly on process and relevance; changes were needed to increase student outcomes. Little evidence of ICT supported student outcomes.
LoU	(3) Mechanical	Teacher did not see any major issues using computers for assessment with her program. She had considered ICT assessments. She had an awareness of the value of ICT support assessments.

Conclusions about attitudes and perceptions of the VA teacher

In this section the discussion is centred on the summary of CBAM judgements as they relate to the attitudes and perceptions of the VA teacher.

Attitudes and perceptions towards using ICT to support assessment

The teacher had adequate access to the ICT required for the course because her lessons were conducted in a computer lab environment; thus no issues with using ICT to support assessments arose. She was comfortable with ICT support, using it regularly in her lessons with the hope of making ICT more applicable for the assessments in the future. This was evidence of a positive attitude towards digital forms of assessment.

267

Attitudes and perceptions of ICT, course and pedagogy

This teacher believed computers to be an important part of her pedagogical practices, using them for teaching and encouraging students to accept responsibility for their use. She wanted her students to research online more thereby indicating a positive attitude towards ICT supporting pedagogy. She would have liked her students to use ICT tools encouraging her students to access electronic textbooks on computers, more evidence she was in favour of ICT support.

Attitudes and perceptions of ICT supporting the AIT exam and portfolio

The teacher saw no weakness in using computers for assessment or the digital portfolio. However, she found the computer-based exam to be different for the students who were not familiar with the process; therefore most were hesitant. She urged for more practice exams so students would be completely comfortable with the exam process. She opined that all students enjoyed the computer-based exam, but enjoyed the digital portfolio more because they were more familiar with its procedures, and were able to show their capabilities in one organised folder. Additionally she thought all students were delighted with the digital challenges, this demonstrating this approach was the way forward for digital portfolios.

She was positive about the whole process and supported the use of ICT for the AIT exam and the digital portfolio. However, it was her intention to meet with other schools doing this type of assessments before collaboration with peers for integration.

Conclusions about attitudes and perceptions of the VA students

This section discusses the summary of results from the student survey and forum discussion regarding attitudes and perceptions of students.

Attitudes and Perceptions towards using ICT

The majority of students used a range of ICT devices on a daily basis, this being similar to the population. They all had broadband Internet connected at home using this medium for work and social networking. Most of them believed computers drove their daily activities, clearly indicating they were not afraid of using ICT.

Attitudes and perceptions towards ICT and learning in the course

Students had no issues with the adoption of ICT in their learning, in fact they welcomed its advent to their course. Most believed ICT formed part of a holistic approach to learning; they were comfortable with this fact of school life. Thus they were likely to have a positive attitude towards accepting ICT as it maximised learning. Most respondents perceived ICT as part of the course because they used in course work on a daily basis in the computer lab. Some conceded they were able to process words faster than to write, clearly indicating a contented positive attitude towards ICT in the AIT course.

Attitudes and perceptions towards ICT supporting the AIT exam and the digital portfolio

Most students agreed it was easy for them to complete the exam using a computer, even though the majority indicated they were inexperienced in computer-based exams. They thought the two best things about ICT supporting the exam were the ease of the exam and its complementing the practical assessment tasks. They had a positive attitude towards and perception of accepting ICT to support assessment for the AIT course.

Case Study XA: Public School

The XA case study involved one teacher and a class of 22 students of both genders completing the AIT course Units 2A-2B by designing a software package for a mobile phone.

Implementation, technologies and isues arising

The class was conducted in a computer lab where students' computers were networked to a central server delivering the application software. An abundance of software was available, students often having a choice of applications with which to work. The school's desktop computers frequently slow down when processing larger files, sometimes, ceasing to respond so needing to reboot. Both observation and comment by both students and XA teacher revealed frequent multi-tasking. The computers were spaced around walls of the room (see Figure 6.7). The school's curriculum computer network system was configured with high levels of security access for students. Students' logon accounts were mostly protected by firewall settings with their logon scripts having limited write access to the school's curriculum server. Students had opportunities to access to a large repository of software for the portfolio and the exam. They completed their design brief for the portfolio product, the

application for a mobile phone using Adobe CS3 Photoshop and MS Office, and also used in the exam.

Figure 6.7 A photo of part of the XA computer room

Results from data analysis

A range of data was collected and analysed, including observation of the classes, a forum interview with a group of students, an interview with the teacher, and a survey of the students. The results of analysis of each of these sources of data are discussed separately in the following section. At the conclusion a summary based on all sources of data is provided as a CBAM analysis and conclusions.

Observations of the class

Members of the research team visited the class on two occasions conducting the assessment task and collecting the qualitative data.

First visit: portfolio product and design process development

On the first visit, the class commenced the portfolio product students were working on: development of a software package for a mobile phone. The teacher modified the content of the design brief provided by the research team before allowing it exactly as intended, including the portfolio and the examination being part of the semester grade awarded. Students worked on the Production phase, completing their planning on templates provided by the teacher. These templates formed the basis for their storyboarding and design processes that were required for the Design Process Document in component two. The activity focused on the application of the whole technology process to a real-world context, as set out in the

scenario contained in the design brief. Most students worked independently but they could discuss aspects of the project with each other.

As a preliminary, the XA teacher gave a short review of the task 'Design a mobile phone package' before students resumed working on the task. They deployed Adobe CS3 for all their design applications, then applied Flash to make an animated logo. The design package included 3 types of logo as a screen saver: Ringtones, Table of contents, Target audience, Issues with product, Software used, Letterheads, Evaluation and References. They employed a 'SPARK' design process with applications such as Dreamweaver, Flash, and Publisher. One student Goggled and downloaded a handheld pen image for his logo; another downloaded a mobile phone shell. All students' work was linked to the school webpage where their work was stored. They also had been briefed on MAPS and had access to 'My Classes Internet' for information and their work.

Second visit: Examination and student survey

This group of students was split into two groups; thus they had ample room to perform their activities. Some confusion arose about the version of the exam, as the older version exam paper was printed at the school necessitating changes to file format, but clearer instructions for opening and saving data.txt in the current version were not made evident to students. The researcher gave verbal instructions to them, which explained such missing information as: open file in Excel and do not use your school name in your exam. Some students asked, 'Can we use text in our images'? Some students were confused when saving an Excel file, that is, Chart.xls must be saved in chart. For task 6 student XA119 asked, "Which PDF do I save it as, fully functional or simple PDF"? 'Do we have to create a video for our display'? All these queries received responses accordingly, the students were happy and proceeded with the AIT exam. Student XA121's thumb drive had no data on it so the thumbnail was replaced with another. Student XA114's computer froze so he was moved to a vacant computer. Two students chose to plan using the planning files provided on the USB. Students couldn't operate the .mov files so they were advised to use .wmv; this worked well. Most students chose the interactive display, but at least 2 chose the poster option.

On completion of the AIT exam, students were presented with and completed, a questionnaire. A student forum, consisting of 5 selected student volunteers, was convened by invitation from the researcher. The group was presented with structured interview questions asked, follow up questions varying according to responses.

Survey of students

Twenty-two students completed the closed and open items in the survey. The results of the analysis of each item are discussed below. A summary of descriptive statistics for the closed items appears in Appendix J.

Closed items

For item E1a nine students reported they had no experience completing an exam or test on a computer before, with six indicating they were only a little familiar. Student XA112 needed much time to become fully cognisant (E1b). Most students expressed the need for more time before they felt confident in doing exams in a computer laboratory. However, the item means absolute difference effect sizes were from 0.12 to 0.22, affirming they needed more time to become familiar exam procedures on computers; in that they were similar to that of the population.

For E2 items the majority of students indicated completing the exam using a computer was easy and useful. The exceptions were student XA113 who was negative towards developing design ideas (E2b), student XA117 feeling the exam did not assist him in developing design ideas (E2h), and student XA122 who was generally negative towards the value of the exam. Item mean absolute difference effect values fell between 0.00 and 0.56 revealing this class was similar in though towards the efficacy of the exam compared to the population. The larger effect sizes were for E2g and h, which showed this group to be somewhat less positive in their attitudes and perceptions of following the steps of the exam and developing their design ideas using the computer.

For items P1a,b most students had completed some portfolios on a computer before more time for familiarisation. With the exception with student XA101, who declared, through experienced he sttill required more training. Student XA106 confessed that, though he had never completed a portfolio on a computer, did not require extra training. Student XA123 did not respond to either question. Absolute values for item mean difference effect sizes fell between 0.14 and 0.32, which indicated that this group was similar in capability to the population.

For all P2 items listed the majority of respondents agreed use of computers was easy and useful in completing the AIT portfolio. Exceptions were with student XA113 who strongly disagreed the computer was good for reflecting his ideas (P2e) and student XA117 who

strongly disagreed the computer enabled him to create his product for the portfolio (P2d). However, absolute values for item mean difference effect sizes were between 0 and 0.34, this cohort was similar to the population.

For Q5 items, four students, (XA101, XA102, XA107 and XA110) were familiar with the full range of the items listed in Q5. Most used an mp3 player, laptop computer, game console, mobile phone and a computer. The least used tools were the video camera and the laptop. Item mean absolute difference effect sizes were between 0.09 and 0.44, indicating that on average they were similar to the population with the use of various computer technologies at home.

For Q6, nineteen students had access to Broadband Internet at home. Three students (XA105, XA122 and XA123) did not respond. On average these students were similar to the population with availability of the Internet at home.

For Q7, the majority of students used a computer at home most days. Five students (XA105, XA117, XA119, XA122 and XA123) did not respond to Q7. An effect size of -0.13 indicated they were similar to that of the population with computer use at home.

For Q8, most respondents spent approximately 80 minutes on average each day deploying computers at school. Student XA110 was the exception in that he spent 240 minutes on average each day using computers at school. The mean for this class was similar to that of the population with extreme variability, in time from zero to 240 minutes. An effect size of -0.01 pointed to the cohort being similar to the population on the time spent using computers at school.

For Q9, thirteen students touch typed using all fingers, two did not touch type at all, and six students (XA105, XA112, XA118, XA121, XA122 and XA123) did not respond.

For Q10 items, most students' responses were positive. The exceptions were the seven students (XA101, XA106, XA107, XA108, XA114, XA115 and XA120) who advised they would not use at least one of the items listed (see Q10a, 10b, 10d, and 10e). Item mean absolute difference effect sizes were between 0.03 and 0.57 indicating no significant difference for this class when the various computer applications are compared to that of the population. The largest effect size of 0.57 was for item 10a, wherein most students indicated they would not keep a list of telephone numbers and addresses of friends.

273

For Q11 items, most students agreed computers were good for the world. They were positive about computers making schoolwork much easier. Most students used computers at home to complete school work. The item means were generally above the population mean. However, item mean absolute difference effect sizes which were between 0.4 and 0.4, indicated these students were likely to have a slightly more positive perception of computer use for their work, but largely they were similar to the population.

For Q12 items, the study students were generally confident in computer use, the exception being one student (XA112) who claimed to lack confidence. The item means were higher than the population mean. However, item mean absolute difference effect sizes were between 0.01 and 0.5 emphasising these students to be as confident in using computers as the population. The item with an effect size of 0.5 was Q12f, most students found difficulty using a computer.

For Q13 items, most of this cohort were shown to have a high level of skill in employing the majority of the items listed, in particular with Word processing, Slideshow, Email, The Internet and Image editing (Q13a, d, e, g and j). Five students did not respond to this question. Absolute values for item mean difference effect sizes were between 0.04 and 0.2 indicating these students' self-assessment of their ICT skills similar to the level of the population.

Open-ended items

Students responded to two open response items which sought the two best and two worst things about doing the exam and the digital portfolio. A summary of responses appears in Appendices P, Q, R and S.

Generally for the two best things about undertaking the AIT exam in the computer lab, were ease of demonstrating their designs ideas with more opportunities for them to be creative. They could generate multiple forms of designs quickly with the use of computers, and it was easier to discover new idea by searching the Internet. For the two worst things about completing the AIT exam in computer lab, most concerned the school's computers freezing, resulting in loss of work, and the computers were slow thus taking time to upload files. Comments were made about the frequent crashing of computers when performing 'multitasking' jobs with consequent loss of time while re-booting the computers.

The two best things about doing the AIT portfolio students considered were its ease and enjoyment, allowing them to show their best work. They were able to hyperlink pages, which gave a degree of inter-activeness within their portfolio. The two worst things undertaking the

AIT portfolio, concerned the intensity of intellect involved with a computer malfunction always possible: 'computer can screw up'.

Questionnaire scales

This section presents the seven scales derived from combining the items of the questionnaire. The results are shown in Table 6.7 and Figure 6.8 with the results for each scale being discussed separately.

Table 6.7
Descriptive statistics for the student survey scales for the XA class

| Scale | XA Class | | | | | Population | | Sample |
	N	Min	Max	Mean	SD	Mean	SD	Effect Size
eAssess	22	2.45	4.00	3.25	0.50	3.03	0.50	0.44
eAssessP	22	2.45	5.00	3.30	0.53	3.19	0.63	0.17
Apply	19	2.00	3.00	2.50	0.35	2.39	0.38	0.29
Attitude	18	2.40	3.00	2.78	0.22	2.63	0.30	0.50
Confidence	18	2.33	3.00	2.78	0.26	2.77	0.27	0.04
Skills	17	2.45	4.00	3.40	0.50	3.33	0.55	0.13
SCUse	22	0.00	230	80	62	79	69	0.01
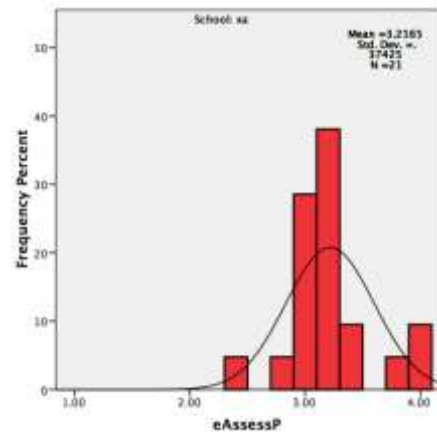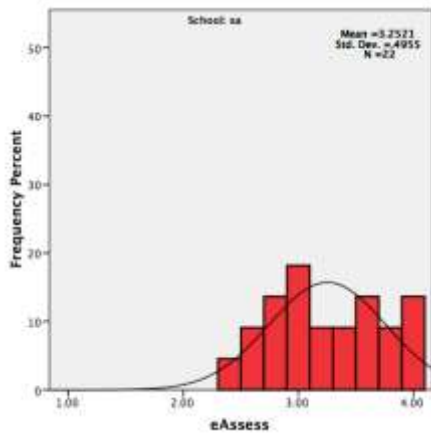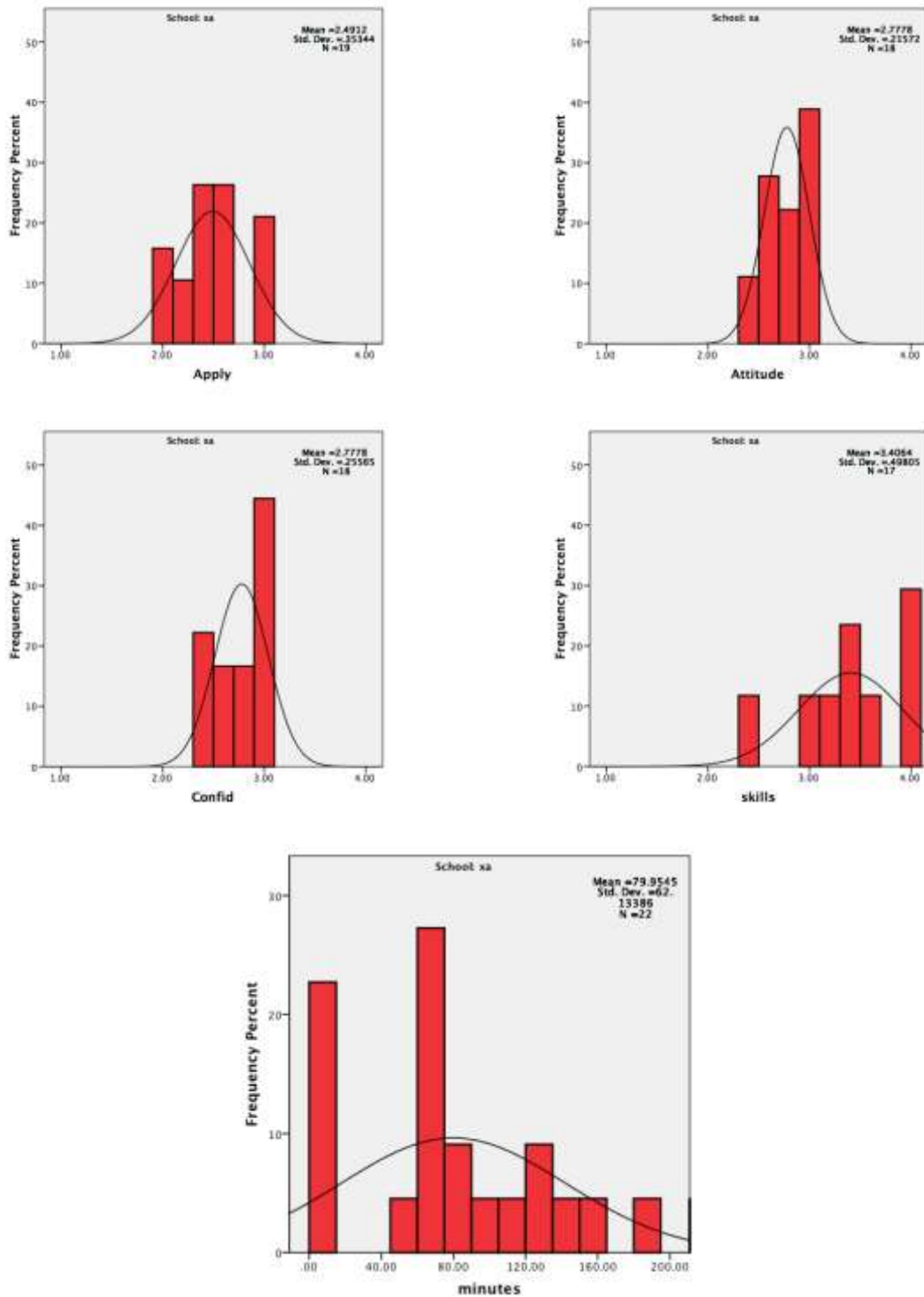
Figure 6.8 Distribution of scores for the student survey scales for the XA class

The eAssess graph showed most students to score above the midpoint of 2.50 with more students clustering nearer the maximum of 4.00. The mean for eAssess was slightly above the population mean with a good spread across the scale (SD 0.50). An effect size of 0.44

indicated that these students perceived they had greater efficacy in using computers in the exam than the population.

The eAssessP graph portrayed a large number of students clustered above the 3.00 scale a few students clustered towards 4.00 level of the scale. The mean 3.30 for eAssessP, was above the population mean. However an effect size of 0.17 showed to be similar to the population when considering the value of completing the AIT portfolio.

The Apply graph showed a good spread amongst these study students with between the 2.00 and 3.00 being the scoring range. The class mean was slightly higher than the population mean. However, an effect size of 0.29 proved this class to be similar to the population.

The Attitude graph depicted most respondents were grouped in the 2.50 to 3.00 scale range. A class mean of 2.78, which was slightly higher than that of the population, showed these students were likely to display a more positive attitude towards using computers as represented in the E11 items. An effect size of 0.50 showed this class to have a more positive attitude towards using computers than the population.

The Confidence graph revealed a large number of students to cluster near the 3.00 score level, having a mean of 2.8, which was close to the population mean. An effect of -0.04 indicated they were confident but not more confident than the population for E12 items.

The Skills graph showed a good spread and skewed positively, having a class mean of 3.40, slightly higher than that of the population mean of 3.33. The majority of participants could manage most of E13 items. However, an effect size of 0.13 indicated their perceptions to be similar to the population regarding these skills.

The SCUse graph recorded there being a large variability concerning time spent each day using a computer at school (E8 items). Six students did not use computers at school. The research cohort's computer usage varied zero to 240 minutes a day. An effect size of 0.01 indicated that on average this group was similar in computer usage at school to the population.

XA AIT students forum

A small group of students was selected as representative of the class by the researcher to interview immediately after the AIT examination. The discussion focused on comparing the AIT portfolio and the exam. The forum students gathered a semi-circle in a classroom; the

outcomes of the discussion are summarised below. Their individual responses to the student questionnaire are to be found in Appendix E.

The students explained being happy and enjoying the exam because it was practical exam a practical AIT course, portray their knowledge visually. The portfolio and the exam were very similar to their usual class work. They commented on to the ease with which they were able to create interactive folders on a computer. They indicated that writing for them was too slow, preferring typing onto a computer. They expressed positively their opinion they performed better, with the computer assisting and they were familiar with it and all the necessary software.

The forum commented on the exam being a new experience a big improvement for a practical course; it was more relevant, enabling them to showcase their work. They were apprehensive they had not before completed a computer exam. They commented negatively about the wording of the exam, it was too complex and difficult to understand particularly for the initial section which lacked clarity as to how the steps were sequenced; they needed more reading time. Concern was evidenced of computers'crashing causing loss work and time during the exam. However, they maintained their positive stance suggesting amprovements could include a practice exam and a greater time allocation in the future.

Forum members commented the portfolio and the exam being similar and they were familiar with the employment of computers in their daily classroom lessons. Assessment tasks by computer for a practical course were appropriate because outcomes are visual. Better practical work with computers was inevitable as they already know how to use computers with all the necessary software already installed.

Pre interview with XA teacher

The teacher gave feedback to the questionnaire by way of an email return prior to his class being involved in the assessments (Appendix G). The following is a summary of his responses.

The teacher indicated his students used computers for most assessment purposes. Had learned software programs, worked on assignments and assessments, and completed class exercises and tests using computers. His wish would be for his students to deploy computers 90% of their lesson time with him.

He approved of the AIT course structure being computer based involving ICT skills thereby enabling assessments based upon these ICT skills. We live in a computer world so it is beneficial to have students computer literate when they join the work force. The only weakness with ICT supporting assessments and learning was the lack of technical support in schools. The lack of sufficient computers for his AIT classes was overcome making laptops available to students.

The teacher was seeking information about using a PC or Mac computers for assessments. He was investigating ICT support for assessments in Australian schools and internationally, commenting that a practical course should have practical assessments.

He was actively involved with the WA Curriculum Council in computer-based assessment programs and school planning with staff on computer-based assessments, for example, creating digital portfolios and sharing best practice in ICT for assessments. He indicated that he was totally supportive of ICT support for assessment in the AIT course.

Post interview with XA teacher

The teacher provided feedback by way of an email return to a set of questionnaire protocol after his class completed the assessments (see Appendix J). The responses are summarised in the section which follows. The teacher's initial remarks regarded the assessment tasks; they were sufficiently comprehensive comprising a good range of topics for the exam. The latter lasted two hours only the teacher believing this to be sufficient time to complete all the tasks. Additionally he opined the structure and timing worked out fine, and feedback from students indicated they understood the requirements. Accordingly he felt most students thought the exam was sufficiently challenging and not beyond their skills; the questions were simplified, logical and clear. The teacher commented on the format of the AIT exam being appropriate for AIT courses, reiterating, a practical course required a practical exam. He asserted there is a need to add a theoretical component with an one hour added to the exam. According to him, a few students did not handle the computer-based exam as well as others, emphasising the need to incorporate ICT supported assessments in the course. However, he commented on the exam being an enjoyable experience, a far better one than the mock theory exam held a few weeks previously.

With regard to technical problems, some thumb drives were empty but generally the provision of materials was well supported. A few spare thumb drives and and spare headphones were

quickly substituted for the faulty items. The only other problem with implementation activities concerned the exam papers being dispatched to the wrong location resulted a late start by ten minutes. Finally, considered the WA Curriculum Council had to be convinced of the benefits of an ICT supported exam for AIT.

CBAM Analysis

The results of the analysis of data from the previous sections utilised in making judgements about the three constructs of the CBAM:- IC; SoC; and LoU employed as a diagnostic tool for analysing the implementation of digital forms of assessment for this teacher. The outcomes of these judgements along with summaries of the evidence supporting them are provided in Table 6.8. The numbers in the judgement column are from the CBAM IC shown in Appendix A.

Table 6.8
Judgments for the XA teacher on the CBAM constructs

Construct	Judgement	Evidence
IC		
Access to ICT to support Assessment	(1) Teacher has access to ICT for assessment at all times.	Teacher had access to ICT for assessments at all times. Therefore it was appropriate to use ICT to support assessments. He did not see any major issues using computers for assessment with his program.
Digital Forms of Assessment	(1) Teacher uses a variety of Digital forms of assessments with his courses.	Teacher used a variety of computer-based exercises and tests with his students. He indicated that his students used computer for most assessments i.e. Digital portfolios that incorporated sound and animation.
ICT and Pedagogy	(1) Teacher uses ICT for most learning activities.	Teacher used a range of devices in the computer lab with students. All learning activities involved the employment of some form of ICT devices.
SoC	(5) Collaboration	Teacher was involved with computer- based assessment activities such as creating digital portfolios with staff in the school.
LoU	(5) Refinement	Teacher promoted and shared best practices in using ICT to support assessments in the school.

Conclusions about attitudes and perceptions of the XA teacher

The discussion in this section concerns the summary of CBAM judgements regarding attitudes and perceptions of the XA teacher.

Attitudes and Perceptions towards accessing ICT to support assessment

The teacher had no concerns about accessing ICT to support assessment in his school, asserting computers should be used throughout the school for assessment and learning. He had a positive attitude and strongly supported using appropriate learning technologies.

Attitudes and Perceptions towards ICT, course and pedagogy

This teacher was proactive towards some of the digital forms of assessments in his school; he had a highly positive attitude towards these forms for the course. He had embraced this form of assessment, contending ICT is a critical part of the learning environment. He was very supportive and positive towards an ICT rich pedagogy. knew the structure of the AIT course components were based on ICT related skills, with students being required to demonstrate the technology process when completing the relevant tasks. He supported the course being delivered with ICT supporting the learning outcomes.

Attitudes and Perceptions of ICT supporting the AIT exam and the digital portfolio

The teacher did not observe any weakness in using computers for the AIT exam because of his contention that for a practical course there should be a practical exam. He affirmed this to be an efficient and meaningful method of measuring student outcomes for the AIT course and the digital portfolio was an efficient way for students to store and organise their work. Most students were familiar with digital portfolios so they used this approach. He was strongly positive in supporting the employment of ICT for the exam and the digital portfolio.

Conclusions about attitudes and perceptions of the XA students

The discussion herewith summarises students' results from the survey and forum discussion concerning the students'attitudes and perceptions.

Attitudes and Perceptions towards using ICT

Students used a range of ICT devices at school and at home, these being part of the normal tools used in their daily activities. They were comfortable with and had a positive attitude towards the use of ICT

Attitudes and perceptions towards ICT and learning in the course

Most students believed ICT was part of learning and the two were seamless, computers being good for the world and made learning much easier for students wherever applied. They had a strongly positive attitude toward learning with ICT. Students' felt at home with ICT in the course, accepting it as an essential tool for their course work. Generally speaking they were confident in using computers, considering they were competent at it. Overall they had a positive attitude towards ICT implementation in the course.

Attitudes and perceptions towards ICT supporting the AIT exam and portfolio

The majority of students considered ICT made it easier for them to complete the AIT exam, conceding ICT support for the exam provided a relevant environment for them to show their competence, and allowing them to demonstrate process in their design task. The only down side to a computer-based exam concerned technical hitches with computers in the lab. For the digital portfolio, respondents considered the process easy and fun be engaged with once they were familiarised. They were highly positive about the value of storing all their work electronically, wherein they were able to hyperlink pages. They could edit and made changes much quicker and easier. Clearly they were highly positive towards the value of the digital portfolio.

These students were happy with the exam, perceiving that a practical exam was appropriate for the AIT course because all the tasks were performance-based. They could their skills digitally being familiar with the digital portfolio and the format of the computer-based exam, expressing gratitude for the computer assistance that helped them do their best quality work.

The students perceived they were inexperienced in completing exams on computers which is contrary to their teacher's opinion they had used computers for most assessments purposes. Their perceptions of exams and assessments varied slightly, for example, the teacher may consider students learning software programs and students producing assignments on computers, tests/quizzes had helped in forming their perception of exam efficacy which was indicated by the high eAssess score.

<h1 style="text-align:center">Case Study ZA: Public School</h1>

The ZA case study involved one teacher and a class of 16 male and female students completing the AIT course Units 2A-2B, designing a website for an on-line sports store.

Implementation, technologies and issues arising

The researchers either met or communicated with the teacher using phone and email before the students became involved. This was to discuss the research and assessment processes and to determine when and where the components of the assessment task would occur. The class was conducted in a computer lab, and all students' computers were networked to a central server which delivered the application software. An abundance of software was available with students often having a choice of application with which to work. The computers were spaced around walls of the room (see Figure 6.9).

Figure 6.9 A photo of part of the ZA computer room

The school's computer network system was configured with high levels of security access for students. Students' logon accounts were mostly protected by firewall settings and students' logon scripts, with limited write access to the school curriculum server.

For the portfolio product the students worked on a presentation for a website for a sports store. The teacher introduced a slight variation to the context of the design brief provided by the research team, thus introducing some degree of flexibility for local customistion. Apart from this the teacher followed the design brief as intended including the portfolio and the examination as part of the semester mark awarded.

Students worked on the Production phase of the Interactive Display and did their planning on templates provided by the teacher. These templates formed the basis for their storyboarding and design processes as required for the Design Process Document in component two. The focus of the activity was the application of the whole technology process to a real-world context set out in the scenario contained in the design brief.

Most students worked independently but they could discuss their project.

with each other.

Results from data analysis

A range of data was collected and analysed, including observation of the classes, an interview forum with a group of students, an interview with the teacher, a survey of the students, and the output from their assessment task.

Observations of the class

This class was visited on two occasions to observe students completing the assessment task or to collect qualitative data.

First visit: product and design process development

During this visit 12 students were present, 4 were absent. Students were working on their portfolio 'investigation' of a product for an online sports store. They were required to demonstrate the Technology process in their process document. Some did an evaluation of a prototype website for the travel industry that could run on a computer in the classroom. Others completed a DVD presentation that would recommend on buying a home computer system.

Second visit: Examination and student survey

During this visit the ZA teacher told of concerns about students saving files in certain formats as the school had installed a new firewall on the network system. As a consequence, all students were requested to logon using the teacher's login account which enabled them to sit for their AIT exam in their normal computing lab. At the request of the teacher, they used the centre area of the lab for their fifteen minutes of planning time after they had access to instructions in their USB thumb drives. Most students continued to plan after the initial fifteen

minutes as they needed an extra fifteen minutes before they accessed their computers. The teacher instructed all students to create their interactive display in the form of a website.

Two students had difficulties opening the data.txt and needed help. One student (ZA110) was moved to another computer and given extra time to complete the exam because his computer was too slow and took longer opening and saving files than the rest of the students. Most students were working on the reflection document when the exam time ended.

On completion of the AIT exam, students were presented with and completed, a questionnaire. A student forum comprising 5 volunteer students was convened by invitation to the researcher. The group were presented with the common structured interview questions with follow up questions differing according to responses.

Survey of students

Sixteen students completed the closed and open items in the interview protocol. The results of analysis of each item are discussed in this section. A summary of descriptive statistics for the closed items is listed in Appendix K.

Closed items

Descriptive statistics were generated and summarised for the closed-response items (see Appendix H). Class means for each item were compared with the population mean for the sample by calculating an effect size.

For item E1a, five students had no experience sitting for an exam or test on a computer before; nine students indicated that they had done little. Students ZA105 and ZA106 had done some. For E1b, most students affirmed they needed some time to become familiar with completing exams in a computer laboratory. However, the effect sizes for both E1a, b respectively were small, -0.04 and 0.17, indicating that, although these students needed more time to become familiar with completing exams on computers they were similar to the population sample.

For E2 items the majority of students found it easy for them to complete the exam using a computer. Student ZA112 was the exception who contended this form of exam restricted his abilities (E2j). Item mean absolute difference effect sizes were between 0.03 and 0.5 this class to be similar in their perception of computer use when compared to that of the population. The larger effect size of -0.5 was for item E2f, using a computer to answer questions in the exam.

This class overall was slightly more positive about answering the questions using a computer in the exam. Perhaps they were familiar with computer-based exam.

For items P1a and b, a majotity of respondents had completed some portfolios on a computer previously, but needed extra time for familiarisation. With the exception of students ZA107 and ZA110 who had not completed a portfolio before, hence requiring much more familiarisation time. Student ZA116 did not respond to either questions. The effect sizes for both of these questions were relatively small, -0.39 and 0.26, which indicated the cohort was similar to that of the population sample for P1 items.

For all P2 items listed most of the study group found it easy completing the AIT portfolio, with the exception of two students who was less positive about using the computer for showcasing their skills both in the portfolio and the production of the extra artefacts, (P2f). One student (ZA116) did not respond to P2 items. Item mean absolute difference effect sizes were between -0.03 and -0.4, which indicated they were generally more positive towards completing the digital portfolio with a computer. However on average their perceptions were as positive as that of the population for P2 items.

For Q5 items most of the research cohort deployed an mp3 player and a mobile phone with the least used items being the video camera and the webcam. No students indicated they used the full range of technologies listed in Q5. However, effect sizes ranged from -0.04 to -0.44 showing this cohort to be similar to the population in the use of computer technology at home.

For Q6, most of the study group had access to Broadband Internet at home, with two exceptions, ZA103 with dial-up and ZA113 having no Internet access. Therefore respondents were similar to the population in their use of computer technologies at home.

For Q7 most used a computer at home on most days, the exception being ZA118 who rarely used a computer at home. Effect size for Q7 was -0.10, thereby expressing they were similar to the population as to the frequency of computer usage at home.

For Q8, most students spent over 60 minutes on average each day using computers at school. Students ZA107, ZA110, ZA112 and ZA113 were the exception, indicating they spent less time. The mean for this class was below that of the population, but varying within the class, from zero to 420 minutes. An effect size of -0.29 revealed they were similar to the population on their average time using computers at school.

For Q9 all students indicated that they touch typed using all fingers, with the exception of student ZA114 indicated that did not touch type at all. The class mean was below the population mean, an effect size of -0.07 that indicated that there were on differences between this class to that of population.

For Q10 items most responses were positive with the exception for Q10a, b and having negative opinions, particularly item Q10a. The class mean was higher than for the population mean and the effect size was -0.11, indicating there was no significant difference between the various computer applications listed, and and their reactions were similar to those of the population.

For Q11 items, most students agreed computers were good for the world. They had a positive attitude towards using computers, considering that computers made schoolwork much easier. Most of them used computers at home to do school work. The class means for Q11a, c and d were above the population mean. Item mean absolute difference effect sizes fell between 0.35 and 0.9 afirming their attitudes towards and perceptions of computer use were similar to that of the population. The effect sizes greater than 0.5 were scored for Q11a, b, c and d thus revealing these respondents to be less positive towards using computers. However Q11e scored an interesting effect size of -0.35 affirmed they were still positive in their belief that computers were good for the world. Additionally, they were likely to have a positive attitude towards using ICT to support assessment.

For Q12 items, this research cohort was confident generally in the use of computers, with some exceptions. ZA103 explained he was not comfortable about trying a new problem on the computer, and ZA103 and ZA112 indicated they could not learn to program a computer. The class mean than the population mean. However, absolute item mean difference effect sizes were between 0.04 and 0.3, revealing these students were as confident in using computer technologies for their work as the population.

For Q13 items, most respondents denoted a high level of skill in using most of the items listed. One student did not respond to the items listed in this question and another ZA103 confessed he couldn't succeed with most of the items listed. However, absolute values item mean difference effect sizes were between 0.02 and 0.4, showing these students' perceptions of their ICT skills were as positive as those of the population.

Open-ended items

The twenty research students completed all the open items. The various responses are shown in the table, Appendix J.

Generally students considered the two best things arising from completing the AIT exam in the computer lab, were that computers made the exam easier and more enjoyable. They were provided with a better learning environment enabling them showcase their skills and demonstrate their ideas. They were able to hyperlinkpages, which gave a degree of inter-activeness. AIT was a practical unit so it was a relevant, practical exam. The two worst things about doing the AIT exam in the computer lab, were minor technical matters: the school's computers froze and they lost their work; the computers were slow and it took time to upload files; the computers often crashed when performing 'multitasking' jobs; their diligent work might not saved or be deleted; and time lost in re-booting the computers.

Generally for the two best things about doing the AIT portfolio, students considered that it was easy and fun to do, and it allowed them to show their best work. They were able to hyperlinked pages, which gave a degree of inter-activeness. For the two worst things about doing the AIT portfolio, students were concerned with lots of work and this might not save or get deleted. Computer can crash and time lost in re booting.

Questionnaire scales

This section presents the seven scales that were derived from combining items from the questionnaire. Results are shown in Table 6.9 and Figure 6.10. Then the results for each scale are discussed separately.

Table 6.9
Descriptive statistics for the student survey scales for the ZA class

Scale	ZA Class					Population		Sample
	N	Min	Max	Mean	SD	Mean	SD	Effect Size
eAssess	16	2.36	3.82	3.16	0.40	3.03	0.50	0.26
eAssessP	15	1.91	5.00	3.24	0.70	3.19	0.63	0.08
Apply	16	1.67	2.83	2.35	0.43	2.39	0.38	-0.11
Attitude	16	1.80	3.00	2.51	0.34	2.63	0.30	-0.40
Confidence	16	2.00	3.00	2.80	0.28	2.77	0.27	0.11
Skills	15	1.09	4.00	3.34	0.74	3.33	0.55	0.02
SCUse	16	0	184	59	4.30	79	69	-0.29
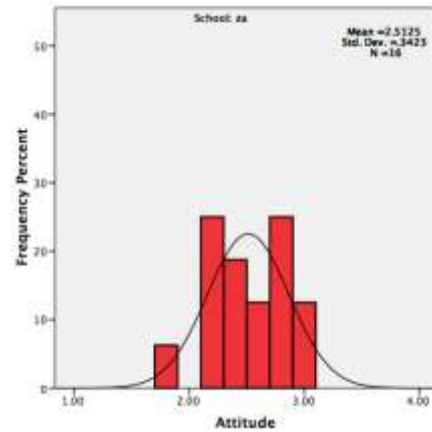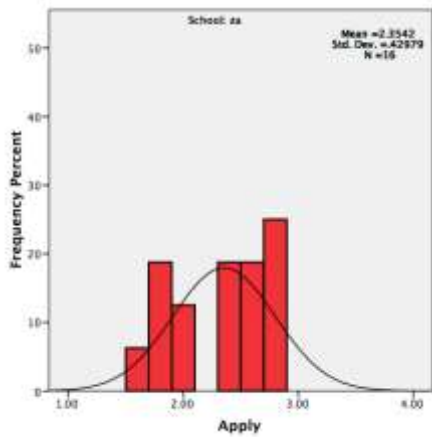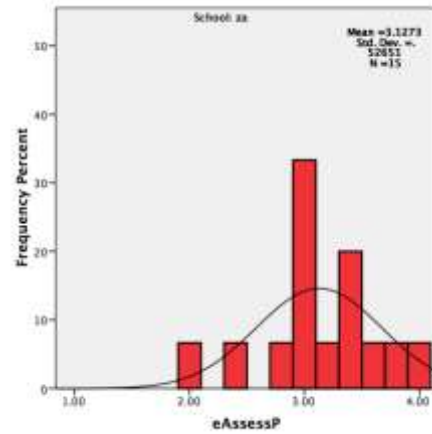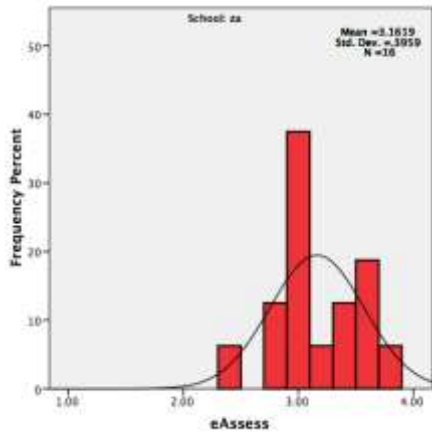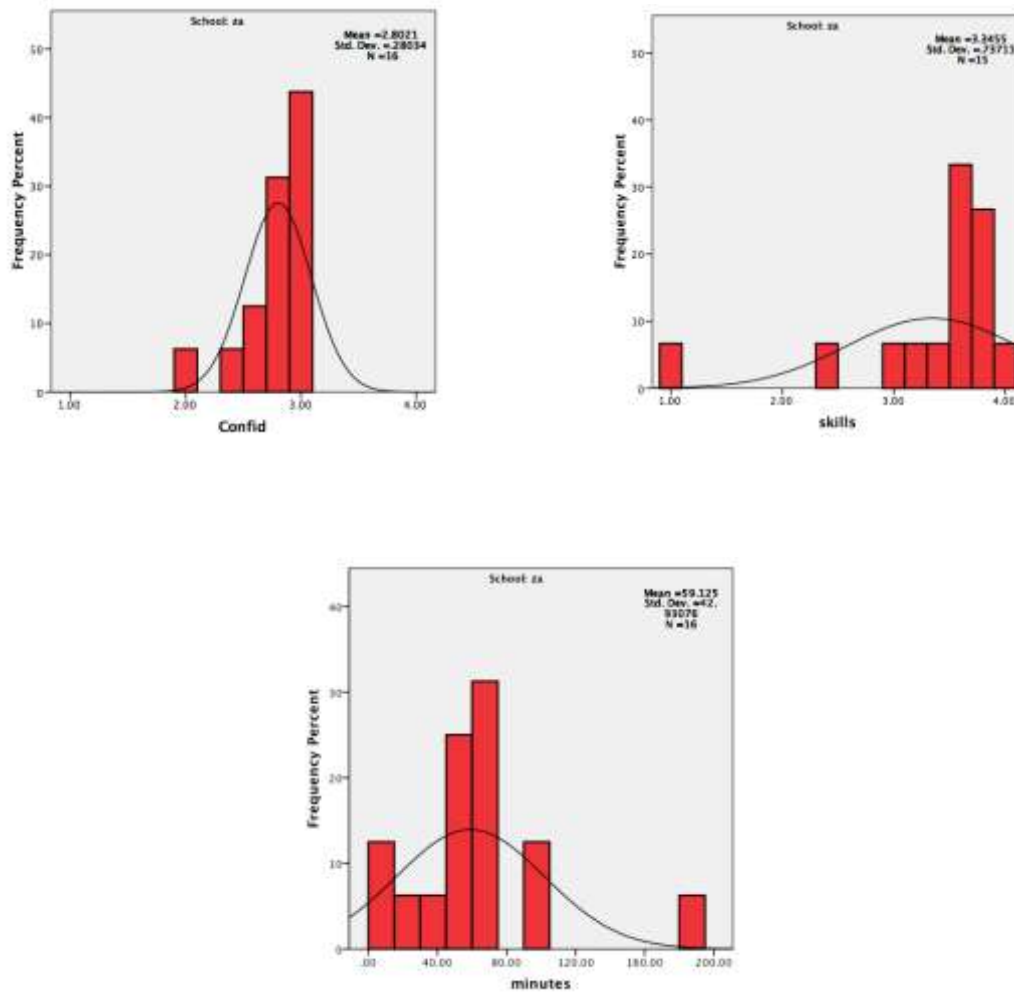
Figure 6.10 Distribution of scores for the student survey scales for the ZA class

The eAssess graph showed most students scoring above the midpoint 2.50 with a mean of 3.16; this was below the population mean, having a standard deviation of 0.40. A larger number of them had higher values indicating this cohort was positive about the value of a computer-based assessment. An effect size of 0.26 indicated this class was not significantly different from the population.

The eAssessP graph pictured a large number of students clustered around the value 3.00 with a slightly higher numbers falling in the higher values. The mean for eAssessP of 3.24 was above that of the population. However, an effect size of 0.08 revealed this class was similar to the population concerning perceptions of the efficacy of the AIT portfolio.

The Apply graph affirmed a good spread amongst the research group, in fact between 1.50 to 2.80. Most scored above the midpoint of 2.00, the class mean being 2.35. Thus slightly fewer students were as likely as the population to use the computer applications listed. However, an

290

effect size of -0.11 indicated this class to be similar to the population in its perceptions of using various computer applications in question.

The Attitude graph shows a good spread amongst the students with scores ranging between the 2.00 and 3.00 on the chart. The class mean for Attitude was 2.51, slightly below the population mean; the effect size of -0.40 indicating the respondents displayed a slightly less positive attitude towards using computers than the population.

The Confidence graph showed little spread, most students scoring above the midpoint of 2.00. Large numbers of students closely at the 3.00 level affirming this class had more confident students than the population in computer use. An effect size of 0.11 asserted they were confident, but not more confident than the population about using computers.

The Skills graph was skewed positively with a mean of 3.34, slightly higher than the 3.33 of the population. An effect size of 0.02 indicated that this class was similar to that of the population with these skills.

The SCUse graph showed a large variation among students concerning the amount of time (0-200 minutes) spent each school day using a computer (QE8 items). Most of the study group spent appropriately 60 minutes on any one-day using computers at school. An effect size of -0.29 indicated this class to be similar to the population with regard to computer usage at school.

ZA AIT students' forum

A small group of students voludered for selection by the researcher for interview as forum representative for discussion of an interview protocol immediately after the AIT examination. The focus was on a comparison between the AIT portfolio and the exam. The forum students sat in a semi-circle in a classroom. The following is a summary of the interview student questionnaire item responses appear as Appendix E of this thesis.

Generally, students enjoyed the AIT exam; however they were concerned with the length of time being too short comfortable completion of the exam. Better oucomes would have been achieved with extra time; as it was they could only cover the basics. They liked a practical exam, opining the previous exam was all theory based, but now the balance between theory and practical better. Some were frustrated with language usage in the exam instructions; they found it too difficult to understand what was required. They had not complete an exam on a computer before, thus they found it very different to previous exms; this was a challenge to

them. They enjoyed completing the portfolio because it was more open-ended. However, they indicated some distress in that the portfolio was too complex because of such terms as 'Digital Artefact' which had no meaning for them. They suggested a glossary of terms could be provided to give a common understanding of terms. A similar concern was expressed about the file formats were required in the exam. A small group of students were selected by the researcher to interview as representative of the class, to interview immediately after the AIT examination. The focus was on comparing the AIT Portfolio and the Exam. For the forum students were gathered and sat in a semi-circle in a classroom. The following is a summary of the interview. Student questionnaire item responses are in Appendix E.

Pre interview with the ZA teacher

The female teacher provided feedback to the questions by way of an email return to questions submitted prior to her class being assessed (Appendix G). The following is a summary of responses to the questions.

The teacher reported her students used computers for graphic design-image manipulation, movie editing film, audio process documentation, programming and software products. She would prefer them to have access to computers 100% of their AIT lessons, contending that AIT is an applied subject, therefore students should be able to demonstrate their skills in a practical manner. Importantly, in the process students would learn about time and process management. The only weakness herein could be the reliability of available resources, such as, apporiate hardware and software. She had attempted to minimise this weakness by liaising closely with the IT manager and the ICT team in the school. She asserted students were keener to manage time more effectively when they are being challenged by studying Design Principles.

The teacher was currently planning to employ computers for assessment for her Year 10 class for the coming year. She already cooperated with four IT staff concerning ICT to support assessment, but was unsure of the extent of digital forms of assessment in other learning areas. She was very open, keen to listen, but will be vetting carefully the implementation of ICT to support assessment.

Post interview with the ZA teacher

The teacher provided feedback by email return to a questionnaire protocol after her class completed the assessments (Appendix J). The following is a summary of responses to the questions.

The teacher commented the assessment tasks were fine;she liked the fact that the Digital Artefacts for the portfolio submission allowed her students to choose a task, mapped to the syllabus, which they completed in class. Howerver, affirmed the instructions were convoluted, meaning the instructions were difficult for her students to understand. She insisted that the term 'digital artefact' should to be changed to Portfolio Submission 1 or Portfolio Submission 2. The structure of the documents requiring students to save relevant files should be streamlined. Reading time should also include time for the students to set up folder structures, this being necessary to re-inforce that addressing of files was absolutely important.

The students enjoyed the activities, particularly the portfolio tasks, which were modified for the delivery of the DVD task in the curriculum. The teacher contended a practical exam must be the way forward. She cited the Education department and Curruculum Council examples were exemplars of clear and straight forward instructions for exam candidates. She used these examples previously in her classes, finding them less confusing. For this AIT exam the teacher found the exam results were very poor compared to her students capability. She commented that the storyboarding section of the exam needed to be better structured, particularly regarding student support in sequencing the solution. Her students' feedback indicated they had been very pleased with the exam process overall but felt more time was necessary if they were to showcase their real skills. They would like more practical exams the exam instructions must be clearer. The only technical problems encountered during the exam concerned the headsets and audio. Further to this she had no other thoughts or suggestions.

CBAM analysis

Finally, the results of the analysis of data from the previous sections used to judge the three constructs of the CBAM:- Innovation Configuration (IC); Stages of Concern (SoC); and Levels of Use (LoU) these being employed as a diagnostic tool for analysing the implementation of digital forms of assessment regarding this teacher. The outcomes of these judgements along with summaries of the evidence supporting them are provided in Table 6.10. The numbers in the judgement column are from the CBAM IC in Appendix A.

Table 610
Judgements for the ZA teacher on the CBAM Constructs

Construct	Judgement	Evidence
IC		
Access to ICT to support Assessment	(1) Teacher has access to ICT for assessment at all times.	Teacher had access to a computer lab and Internet for her AIT class. There were opportunities for ICT supported assessments in this case.
Digital Forms of Assessment	(4) Teacher does not use digital forms of assessment, but may use ICT to collate marks and recording.	Teacher was currently planning to use computers for assessment, but had not embarked on any yet.
ICT and Pedagogy	(1) Teacher uses ICT for most learning activities.	Teacher used graphic design image manipulations, movie editing and programming with her students.
SoC	(3) Management	Teacher was keen to listen and will vet carefully the implementation of ICT to support assessment.
LoU	(3) Mechanical	Teacher indicated that she was not looking for any information about using computers for assessment. She was not sure about digital forms of assessment in other learning areas. Her focused were mainly on environmental and technical issues with ICT.

Conclusions about attitudes and perceptions of the ZA teacher

This section discusses the summary of CBAM judgements regarding attitudes and perceptions of the teacher.

Attitudes and Perceptions towards using ICT to support assessment

The teacher had access to ICT at all times and is currently planning to employ it for assessment in the future. She was happy using ICT in her lessons and preparations, and had considered exploring ICT to support assessments when there is appropriate support and training at her school.

Attitudes and perceptions towards ICT, pedagogy and course

She would prefer her students have more access to varieties of ICT for their work in general, but felt that ICT to support digital forms of assessment were generally fine. However, it was too early to commemt fully the value of its use. She tended to be at the 'mechanical' (LoU) stage of ICT for assessment indicating a positive attitude towards accessing ICT to support assessments when appropriate. She contended the delivery of the AIT course work should be based more on graphic image manipulation, movie editing, audio process documentation and programming. ICT was a valuable tool for teaching and learning in an ICT rich course

294

environment Thus she would be happy to assist with future research into the use of ICT to support pedagogy in the delivery of the AIT curriculum. The AIT course was a performance-based subject; therefore students should be able use ICT to demonstrate their skills in a practical manner, she asserted, adding that using a range of ICT should enhance learning and meaningfully engage students.

Attitudes and perceptions towards ICT supporting the AIT exam and portfolio

This teacher believed the computer-based exam was appropriate, most her students being familiar with performance-based tasks, even though only a few had experienced a computer exam. She emarked the exam instructions were not clear enough and needed clarification. However her students were positive about the exam because they were practised in digital portfolios.

Conclusions about attitudes and perceptions of the ZA students

In this section the discussion concerns the summary of results from the student survey and forum discussion of attitudes and perceptions of ZA students.

Attitudes and perceptions towards using ICT

Students used ICT on a daily basis in class and intimated computers were important for the world. They believed ICT was the needed for social networking as well as being enjoyable to engage with in most of their schoolwork and communication with peers. After their current experience they were sure ICT would become an efficient tool for all assessments across practical subjects throughout schoolwork.

Attitudes and perceptions towards ICT and learning in the course

Students agreed the AIT course was performance-based and problem solving thus the assistance of ICT was appropriate. They enjoyed learning with computers, most employing ICT on a daily basis in the pursuit of knowledge and in most of their learning. Students enjoyed the AIT course, considering its large practical component required the employment of ICT so as to reflect the practical aspects of the tasks in the course meaningfully. The AIT course, according to them should be more ICT focused and supported, as most of the tasks required them to demonstrate performance-based outcomes that required such support.

Attitudes and perceptions towards ICT supporting the AIT exam and portfolio

Students reported the AIT exam to be challenging because most of them were not familiar with computer-based exams; thus a practice run before the actual exam would enhance their confidence. Some suggested the need for extra time to enable them to perform better.

However, they enjoyed completing the portfolio, especially the open-ended tasks, because the latter was reflected in their normal classwork. They considered having opportunity demonstrate their best work with the support of ICT. Their attitudes towards, and perceptions of, the digital portfolio were relatively strong. Overall they were content with both the computerised exam and the digital portfolio, asserting they would prefer this format for all future assessments.

Conclusions from the AIT Case Studies

This section summarises the five AIT case studies and discusses the findings regarding the teachers' attitudes and perceptions towards the implementation of the AIT exam and the digital portfolio. Then the five case study implementations are compared and a mapping for each teacher relative to the three CBAM constructs is narrated.

Summary about the implementation of the AIT exam and digital portfolio

Five AIT teachers of senior secondary classes with a total of 94 students were involved in the implementation of the AIT exam and and digital portfolio. Students completed the three components, digital product, process document, and two other artefacts of a reflective process portfolio within four weeks of their normal lessons, prior to entering the AIT exam. The aim was for each student to complete a portfolio of digital artefacts and documents covering the investigation, design, production and evaluation of a prototype website for the travel industry, which must run on a classroom computer. The class teacher facilitated the digital portfolio.

The focus of the performance tasks was the application of the whole technology process in a real-world context, as set out in the scenario contained in the design brief. Overall the aim was to be as open-ended as possible to allow a variety of contexts and student creativity. The performance tasks for the computer based exam were readily implemented for all classes with slight modifications to some schools' computer hardware system configurations to the USB ports.

Both the exam and the portfolio were implemented successfully in all schools and any arising were mainly technical in nature and addressed at the point of occurrence. all students completed the exam and most students uploaded their digital portfolio on completion of the exam period.

Similarities and differences between the implementations

This section discusses the process of implementing the exam and digital portfolio and reports on similarities or variations occurring between the five schools.

Attitudes and perceptions of AIT students

Implementation of the AIT exam

The implementation of the examination tasks were similar across the five case studies using their schools' computer networked to a central server, this delivered the application software. Hardware and software were restricted to those available at the school. All schools had an abundance of application software available and students had choices of which application to work with. Student in four schools completed a two-hour exam successfully within the schools' timetable with a slightly modified version for the NA school, as this school had a one-hour block of allocated exam time, compared to the other four schools with two hours for the AIT exam. The AIT exam was implemented without any significant difficulties. There were no logistic issues and any concerns were fundamentally with bandwidth, and computers lacking memory for some multitasking tasks. This issue was common throughout all schools involved in this study. No students completed the AIT exam prior to the allocated time. At the completion of the exam students uploaded their exam folder into the MAPS, a learning management system storing students' work.

 Some slight variations to the implementation of the exam were with the OA case study where students completed the two-hour practical exam during the school holiday period. They were required to complete a one-hour paper-based theory exam for their teacher immediately prior to the AIT performance exam. This was the only school where students set their AIT exam in the school holiday period. For the VA case study, their students did the exam in an Apple iMac environment. The other four schools did their exam on the windows operating system running on PCs. ZA case was different because the teacher insisted on all students doing the interactive display and sitting away from computers for the first 15 mins.

Implementation of the AIT portfolio

AIT Teachers in the five schools implemented the portfolio during their normal class lessons over a period of 4 weeks. An electronic copy of a template for the design process document organised into four sections: (Investigation, Design, Produce and Evaluate, was provided to the teachers. The focus of the portfolio component was on the application of the whole technology process to a design challenge associated with the real-world. Teachers were permitted to set the context of their own design brief for the portfolio product. Three teachers, NA, OA and VA, used the default template, while the other two, XA and ZA used their own design contexts allowing students to customis their designs. Each of these schools incorporated the three components noted of the portfolio. The portfolio product development was intended to encourage teachers to use this digital portfolio as part for their semester assessments.

Attitudes and perceptions of AIT teachers

The discussion herewith concerns the summary of CBAM mapping for all groups of teachers; it will discuss the judgements made regarding their attitudes and perceptions. A summary is provided in Table 6.11. The numbers in the judgement column are from the CBAM IC in Appendix A.

Table 6.11
CBAM mapping for AIT teachers

Teacher	IC			SoC	LoU
	Access	DFA	Ped		
NA	1	3	1	2	3
OA	1	2	1	3	3
VA	1	2	1	4	3
XA	1	1	1	5	5
ZA	1	4	1	3	3

The CBAM IC mapping shows teachers across the five case studies were judged the same for two components of Access and Pedagogy and DFA with a range from 1 to 4. They had good access to ICT supporting assessments was evidenced by the rating of 1 for all teachers on the Access component. They were all rated 1 on the Pedagogy component, 'teacher uses ICT for most learning activities.' They all had access to and used ICT in their pedagogy as evidenced by the rating (1). They varied considerably on the DFA component from a teacher who used a

variety of forms of assessment (XA) to one did not (ZA). Although teachers were aware of the potential, the value of ICT supporting assessments was not fully realised in their course. Two teachers (NA and ZA) were rated 3 and 4 respectively on the DFA component, 'teacher uses no alternative ICT assessments with their courses', and 'teacher may use ICT to collate marks and recording'. Two teachers (OA and VA) were rated 2 on the DFA component, 'teacher may use one form of digital assessment'. The NA teacher used no alternative ICT assessments in his course, being a beginner in the usage of some forms. The ZA teacher was rated 4, as the 'teacher does not use digital forms of assessments, but may use ICT to collate marks and recording'. This teacher thought she employed ICT regularly for assessments, but only collated and recorded student scores. The XA teacher was the only one rated 1 on the DFA component, 'teacher use a variety of digital forms of assessments tasks with his course'. He used digital portfolios incorporating sound and animation in assessing students' ability to keep the sound and image synchronised when sound and vision appear together, and maintain the original video size on presentation. The SoC judgements showed clearly that three teachers NA, OA and ZA, were mostly concerned with process and task management, as evidenced in their first interview comments such as,

> '… possible use some form of quizzies or multi choice WEB2 programs, liked to see more of students learning application of IT, NA' ' … sought to improve the delivery of assessment in the AIT course by sourcing more exemplars OA' and ' … keen to listen and will vet carefully the implementation of ICT to support assessment. ZA'

Although these three teachers supported ICT in the assessment for this study they were in the early stages of adopting ICT for assessments in their courses. Two teachers XA 5 – Collaboration and VA 4 – Consequence, were mapped with higher SoC. The XA teacher revealed in the first interview being involved with computer-based assessment activities such as creating digital portfolios and deploying ICT for most assessments with staff in the school. Thus his focus was on collaboration and being concerned with coordination and cooperation among others regarding use of ICT for assessment. The VA teacher affirmed in the first interview that her students used computers regularly in class, but not for assessments, this inferring she was aware of the impact and consequence of ICT assessment in her course, and the relevance of its use with her students. All five AIT teachers had positive perceptions about the efficacy of ICT for assessment in the course.

The CBAM LoU mapping shows a range of levels (3 to 5) for teachers across the five case studies. Three teachers (NA, OA and ZA) were in the earlier stages of adoption level 3 'mechanical', where they were considering use ICT for assessments, for example,'*NA teacher used some form of quizzies for student centred learning'; 'OA teacher used computers for completing tasks/assignments';* and *'ZA teacher used computers for graphic design and movie editing'.* Their employment of ICT was mainly centred on processes, management and learning activities, but gave no evidence of application in their course to assessment beyond the study.

The LoU, 3 'mechanical', was aligned to implementation of the DFA component wherein the researchers provided the task and instructions to be followed by the study cohort of teachers. Teachers' focused mainly on processes and procedure, and in invigilating the exam and the digital portfolio. This was mechanical according to LoU with little above this level of use being needed regarding teachers' implemention of the DFA component.

The VA teacher considered she used ICT regularly in class for presentation, being aware of the potential of ICT for assessment; she was judged at level 4, a 'routine' user and keen supporter of ICT for assessments in the course. XA was the only teacher to have employed ICT for assessment in his course; this was evident from comments made at the initial interview wherein he informed that his students had already completed tests using computers in class. He was involved in the promotion of computer-based assessment across the school and the Curriculum Council. He scored level of use (5) with ICT to support assessments. Generally, all teachers had positive perceptions of the value of ICT to support assessment and learning in the AIT course.

Attitudes and perceptions towards using ICT

The majority of these teachers spent a large amount of time doing their lesson and resource preparation on computers. They all had access to ICT and were familiar with the Microsoft Office suite of applications and more specialised software they employed at school. In general, AIT eachers in this study were savvy in the use of ICT. They delivered their course work in a computer lab.

Some teachers were more advanced in using ICT in monitoring and evaluating their students and employing some ICT in applications and simulations. They all had opportunities to use a range of ICT. Although not many integrated ICT for assessments in their current classes, most

were keen, valuing ICT in their teaching and learning environments. Most of them believed in ther competence with ICT. Teachers throughout the five case studies employed a range of ICT in their teaching and learning environments; they were familiar with and believed that the AIT course using ICT had motivated and enhanced students learning. Most used visual and animated software programs when introducing or presenting a topic in their class, mostly by PowerPoint or electronic whiteboard. In some cases, students were encouraged to present their work in digital forms, such as a video clip, to promote a product or service.

Attitudes and perceptions towards ICT for digital forms of assessment

One teacher, XA had integrated ICT to support assessment into his course work, the remaining four being less advanced in their attempts with ICT for assessments. All those involved in this study believed that using ICT to support assessments was a positive move and were very supportive of the approach used in the AIT exam. They all felt that the computer-based exam complemented the AIT course, finding it was one way which authentically reflected students' practical performance in an applied course. They believed their students tend to focus on, and were more motivated by practical performance. Most were familiar with digital portfolios and had encouraged students to use them.

Attitudes and perceptions of ICT in course and pedagogy

All teachers followed the teaching curriculum prescribed by the Curriculum Council. They had varying degrees of teaching experiences and employed various teaching strategies with the AIT course. They knew it should have a large practical component. One commonality was they would like to see more ICT time allocated to their teaching and learning curriculum, thereby supporting the concept of using more ICT in their classes. They believed their students enjoyed using computers in their class and ICT could only enhance their engagement the teaching and learning provisions.

Generally all teachers affirmed AIT to be an applied course, thus the nature and the structure in the delivery of the subject should meaningfully reflect the practical components of the course. ICT in this course has the potential to help students to demonstrate the practical values of the course more appropriately, and to show the technology process in a more meaningful manner than the traditional, theoretical approach.

Summary

This chapter has reported and analysed the data collected for each case study in AIT. All teachers supported a computer-based exam and digital portfolio for the AIT course. Their strong positive attitudes and perceptions towards the efficacy of ICT supporting assessment are clearly evident across the range of results in this study. Although some may be in the early stage/s of implementing ICT to support assessments, most were aware of the value and positive impact this could be evident in student performances in a practical course like AIT.

All students were keen for future AIT exams to be supported with ICT, asserting it to be a meaningful way for them to demonstrate their capecity for creative work. They were enthusiastic and believed they were more engaged on this occasion than they have been on a computer exam previously. Their comments were generally positive towards the format of the exam and digital portfolio assessments. Their only negative remarks concerned minor technical functionality issues within the schools 'infrastructures, the progreess of time being sure to improve these situations with the advancement of ICT.

The next chapter will discuss the summary of the findings from the analysed data from earlier chapters as they relate to the research questions.

CHAPTER SEVEN:
SUMMARY AND DISCUSSION OF RESULTS

Introduction

This chapter presents the discussion and summary of the findings analysed in chapters 4, 5 and 6 and relates them to the research questions. This discussion will then lead to conclusions in the final chapter. The research question was:

> *In what ways do the perceptions and attitudes of teachers and students towards the use of ICT in learning affect the feasibility of using digitally based representations of student work output on authentic tasks to support summative performance assessments for the Engineering Studies and AIT WA courses?*

The discussion is framed around the subsidiary questions (1, 2 and 3) and later combined in the chapter as they relate to the overarching research question. The subsidiary research questions were:

> *1. What attitudes do students and teachers have towards the use of digital forms of performance summative assessment?*

> *2. What similarities and differences occur in student and teacher perceptions and attitudes towards ICT in assessment between AIT and Engineering courses?*

> *3. What effects on the feasibility of digital forms of assessment do teachers and students attitudes and perceptions in AIT and Engineering have?*

At the outset, the discussion focuses on the attitudes and perceptions of the students and teachers towards ICT, and ICT in assessment and learning. As stated this discussion draws on information from the previous three chapters wherein data were drawn for analysis from classroom observations, student forums, student surveys and teacher interviews. Additionally an analysis using the CBAM (Hall, 2010) together with these data will be used to support this discussion.

The following narrative will focus on the first subsidiary question. In order to compare the findings about students' and teachers' attitudes and perceptions towards ICT in assessment between the AIT and Engineering Studies courses, a summary and discussion of the findings for each course is discussed separately. Then follows a discussion comparing findings

between the courses. This section concludes by discussing the findings for the second subsidiary question with a similar approach.

Attitudes and perceptions of Engineering students and teachers

This section discusses the attitudes and perceptions of Engineering students and teachers towards ICT use in assessment, particularly in the computer-based practical performance exam completed in this study.

Engineering Students –attitudes

Nealy 80% of students enjoyed using computers and affirmed that computers were good for the world. This was evident in all the Engineering cases (Q11e). Their tendency was to believe ICT was fundamental to Engineers in their profession. According to them this was the norm in the real world so generally they liked using ICT in Engineering Studies, striving to make the connection between Engineering Studies and career Engineers. This was evident from their responses to survey items (Q11 items) where over 76% had a positive attitude towards computers and enjoyed using them. Other positive comments in the open response items were summed up by one student, ' … they wanted a practical tool for doing the Engineering learning tasks, they enjoyed using computers for work and recreational activities'. This was also relflected in (McGaw, 2006) when he promoted the concept of assessment to fit for purposes. Such responses conveyed their enjoyment of the connection between computers and the real world of computer use. Further, they enjoyed using ICT to communicate and interact with social media sites. Their enjoyment of digital technologies would seem normal, as they have grown up in the Generation Y era of technological advances. This was also evident in some of the literature about Generation Y students and their preference for digital technology in their lives (S-Baden, 2015).

Most students liked using ICT as a part of their learning and assessment in Engineering Studies because they believed employing computers when undertaking Engineering learning tasks was normal and natural in the course. This supported the belief that digital forms of assessment could align with pedagogic and curriculum intentions (S-Baden, 2015). This was evident from their responses to the 'open items' on the best things about using computers such as, '… Engineers in the real world used computers in their work'. Therefore this is another indication from the findings in this study about their positive attitudes towards using ICT. This confirms their thoughts about utility in their course work and in exam tasks

supported by ICT in this study which also mirrored the views of their teachers from teacher inteviews. This perception was echoed in all in all the case studies and reflected the views in the second year report in the Engineering section of the larger study (Williams, 2012).

Engineering students saw use for computers in designing and modelling because it was more realistic, allowing them to showcase and present images in their projects. They thought their work to be more interactive, relaying the sense of realism in modelling using computers. This was alluded in student survey items (E2) and student forums where most student perferred modelling with the use of computers in this study. Their responses to survey items (E2) where 93% scored above the midpoint 2.5 on the eAssess scale showed their satisfaction. They were particularly positive about using the computer for recording and modelling the design project (E2 d and i items). Their responses to these items mostly 'strongly agree' and 'agree that the computer was good for recording their design and modelling their design project; they were positive in their attitudes towards the efficacy of a computer-based exam.

Students from all case study groups were keen to see a computer-based exam for Engineering Studies, because they considered the computer assisted them to improve the quality of their work, especially in designing and modelling. This was particularly evident from their comments in the open response items wherein most students were keen to show their competence and wanted others, such as examiners appreciate their talents when using ICT to support their work. Their keenness to embrace a computer-based Engineering Studies exam is evidence of their positive attitudes towards the value of ICT to support assessments.

Engineering Students –perceptions

Most students percieved that they were skilled in using computers in design projects. This was evident from their response to E1 items in which 85% of these students considered they would only need between some and little time to become familiar with this type of work, even if they were inexperienced. This finding alluded that the majority of these students was overwhelmingly confident in their computer skills regarding design projects, evidently this was also reflected in their perceptions about the use of computers to support design projects (E2). Similar evidence from this study were also found in the open response items on the best things about using computers in showing the design process, where most students 84% to 93%, selected 'Yes' in their responses to question Q12 items. These perceptions of confidence in computer skills resonated well with their highly perceived skills of doing well with computers; this was indicated in response for Q12 a, b and d items. Only 10% across the

groups tended to believe they were beginning users of computers, and as such they considered themselved to be less confident using computers with design projects. These respondents were mainly ESL students, as their computer literacy was limited, thus needing extra support.

Most students believed they were experienced with ICT use being generally positive about their skills in using ICT. This was evident from their responses to ICT devices listed in the survey (Q5). On average 74% of them affirmed their use of one or more of the devices, with more than 80% using mp3 player, mobile phones, digital cameras and laptops. Their access to Broadband was almost total, 95%. This probably explains, their responses to Q13 items (e – Email and g – The Internet) where most students (70%) considered they could employ such advanced features as adding a signature and attachments to an email. They used complex searches, downloaded and installed plugins, used different browsers and altered browsers' preferences. These findings in this study clearly alluded that these students were experienced and knowledgeable with computer technology.

Most students agreed computers were useful in designing, modelling, recording and representing ideas in the exam. Their responses to survey items (E2 b, c, d, g and h) showed agreement that computers were useful in the exam by making tasks easier and improved in execution. This was evident in the findings from the design project based assessment used in Engineering case studies, that they had enough experience and sufficient skills with design project work with computers because they were confident with computer use for most learning activites.

In addition, students' comments to the open response items seeking the best things of the exam, were generally centred around designing, recording and modelling using a computer, comments being, '… recording and playing back of videos on a computer enabled a more detailed viewing of designing processes; … easier to edit design work and … the ability to upload and download images or photos; and … helps with designing and easier to share ideas across a larger audience'. These responses showed their acceptance of the value of ICT supporting the improvement in the quality of their work that was in this study.

Most students found the computer-based exam itself to be a new experience. Their answer to a question from the forum, 'was a computer-based exam different to what you normally do?' was overwhelmingly said 'yes'! This was evident from observations of students doing design projects on computers under exam conditions, where each activity was time controlled. Although new to a computer-based exam, they believed in their ability perform well and

welcomed the experience. This alluded in their perceptions wherein they grew up in an information age where 21st century tools were part of their life. This was also evident in this study particularly from their responses to survey item 10f, in which they indicated their familiarity with social media sites. Another response during the forum supported this view; they believed future exams should be conducted with current technologies, that is, ICT supported exams. This complemented their perspectives on ICT being part of life.

Generally the majority of students in the five Engineering case studies in this study held similar views in terms of their skills using computers and implied that although computer-based exam was somewhat different they were indifferent to it. They formed the opinon that growing up in the digital age, they would not require extra time in getting used to computer-based exams.

However, there was a small cohert of ESL students, particularly within the RE case, with limited computer literacy and additional support was provided for them in doing the computer-based exam. They may have lacked literacy skills, none the less were as positive as the other students in all Engineering case studies.

Engineering teachers – attitudes

Most teachers liked their students using computers for Engineering Studies learning tasks, probably because they believed it better engaged them and improved their learning prospects. This was alluded in this study from teachers' initial interview responses to Q5d were to be expected: All teachers would prefer students using computers 100% of the time in school. They positively encouraged computer use for assessments because they liked the students to be more creative with the activities. The majority (95%) of the teachers agreed with the computer-based exam in the Engineering Studies course because they observed the students enjoying and valuing ICT support in completing the design project. Their responses to the post interview questions were positive with comments such as, 'students were positive about the value of using computers for the exam, and computers were good for the design project'' (WE), "computer-based exams have excellent potential for other subjects in the school'' and "I would like to see this format of assessment endorsed by the Design and Technology department in the school'' (RE), "computers for assessments captured students work in real-time" and "provided timely feedback, provided a fairer assessment of students ability for performance-based tasks'' (LE). This also concured with a sense of fairness in assessment inferred by (Mislevy et al., 2013).

307

Two teachers (LE and RE), were clearly worried about the management and engagement of students during the exam. They thought the duration for completing some of the task activities in the exam was too generous and for some students who completed a time-bound activity more quickly than others had to wait for instructions before being allowed to proceed to the next activity. They sensed the possibility of students' concentration waning during exam tasks, and others may need extra guidance in order to maintain exam formality. Thus these teachers were a little less positive towards the management of the exam, and were proactively seeking refinements to manage the exam process better.

Engineering teachers – perceptions

Most teachers intuited that ICT could be used to support assessment, learning and teaching in Engineering Studies. They considered it should be part of the course because their students were more engaged in learning when ICT use was appropriate. All teachers believed that students were inclined to be more responsive in an ICT rich learning environment. Comments from teacher interviews support their perception of the value of ICT supporting pedagogy:

> *… Students responded well to the use of a computer in designing the project (GE),*

> *… Computers could be used to promote authentic assessment' and reinforced cognitive learning (HE and RE),*

> *… On-line assessment would allow students to do so wherever they were ready (LE)*

> *… Teaching and learning in a practical environment needs ICT support (WE).*

All the teachers assserted that using ICT for assessment would better align with the pedagogy appropriate to the course, insisting that using ICT to support assessment for performance-based tasks was appropriate and relevant. Their responses to the pre- and post-interviews, underlined their beliefs about relevance, consistency, naturalness, and meaningfulness for practical course work. However, their uses of ICT were mainly to support presentations and most were early adopters of ICT to support assessments. The GE teacher was focused on using ICT for teaching and learning but there was little evidence of use for assessment, although his keenness to support ICT in the course was evident. The HE teacher was aware of the need for ICT to support assessment, but showed no evidence of positive activity in his course. The LE teacher was extremely supportive towards ICT for assessment, feeling it gave a fairer representation of students' ability, but had not used for his assessments. RE and WE teachers had no plans to use ICT to support assessment at the time of the interview, but were

keen to test or adopt some digital forms of assessment. The lack of implementation of digital assessment suggests that their perceptions of suitable pedagogy might not have been realised yet. Their beliefs about the value of aligning ICT for assessment with the Engineering course was yet to be realised practically.

Nearly all these teachers thought that ICT supported assessments were appropriate in measuring performance-based tasks; they tended to perceive that ICT allowed for better judgements of students' performance. Students doing the design project with a computer in the exam were assisted in showing quality work which could be validated reliably. This was evident from three teachers' responses (GE, HE, and LE) to the post interview questions, '… students responded well to the content and process of the exam (GE);… it was sound and appropriate (HE); and … the quality of students work was good (LE)'. Two teachers' (RE and WE) perspectives of their students' work were a little less favourable because they believed the lack of time and choice of materials in the exam may have compromised the quality of work.

All teachers believed their students would be more engaged with learning when using ICT in Engineering Studies, this engagement would be influential across all learning areas of their schools. They believed employing ICT with students could promote a more holistic and collective ICT culture across the school population. Their responses to Q10 in the post-interview regarding collaboration on using computers for assessment was proof of their support for ICT-supported assessments in other subjects or learning areas.

All teachers agreed that practical tasks in Engineering Studies required a more visual approach in presenting practical components of the course; they perceived ICT to be a useful tool by which to convey this medium of instruction. When interviewed most teachers' beliefs centred on the use of ICT for presentations and instructional purposes, believing this to be visually stimulating and engaging for delivering the practical components of the Engineering Studies course.

Attitudes and perceptions of AIT students and teachers

The following section discusses the attitudes and perceptions of AIT students and teachers towards ICT use in assessment and in particular the two AIT assessments: the digital portfolio and the computer-based practical performance exam completed in this study.

AIT students - attitudes

Most students were generally positive about ICT in general. This was evident in their responses to the survey items Q11 a, b and e where 72% were happy using computers at school and at home. Eighty five percent enjoyed communicating on social media sites like MySpace, Facebook, and YouTube (Q10 f), and 68% acknowledged computers to be good for the world. Their responses to survey items 12 a, b, c and d showed over 70% felt confident and enjoyed computer use. The only exception was survey to item 12 where 55% were concerned about programing a computer, partly because they had not had previous experience with programing of computers in general as this was not needed in most of their learning tasks.

The majority of them enjoyed, and were generally positive about, using ICT in the course, partly because they saw the value of ICT for doing tasks required in the course. This was evident in their responses to the survey items Q5 about experience, use and knowledge with computer technologies, recording that 70% frequently used MP3 players and mobile phones. This positive attitude towards using ICT in the course indicated these students would be likely to find the course enjoyable because of their experience and knowledge of computer technology.

The majority of students enjoyed and were generally positive about using ICT in the AIT exam; They denoted ICT to support them in completing the assessment tasks. Their responses to the survey items E2 showed 60% to select 'agree' for ICT having made a difference during exam time because it was easier and quicker than a paper-based exam (items a, c and k).

Around two thirds of students in all case study groups enjoyed using, and were generally positive about, ICT when completing the digital portfolio which enabled them in showcasing their best quality work. Using a computer to collect and present information of their product was easy and helped them in developing and reflecting their ideas in the documentation for the portfolio. As proof their responses to survey items P2 recorded more than 60% selected 'agree', contending,' *it as easy using the computer for doing…*(P2a); *it was easy using the computer for developing ideas…*(P2 b) *it was a quick way for presenting ideas…*(P2c); and *it was good for reflection…*(P2d).

AIT Students – perceptions

Almost all the student cohort for this research perceived that, in general, they had good ICT skills. Their responses to survey items (Q13 a, d, e, f, g, h, i and j) were supportive, over 50% indicating they were between 'highly' skilled and 'competent' with applications such as word processing, slideshow presentation, emailing, file management, the Internet, webpage authoring, digital photography and image editing. In addition, an average 80% of students told they deployed one or more of the devices, computer, digital camera, video camera, MP3 player, laptop, game console, mobile phone or webcam listed in Q5 of the survey. This partly explained their understanding of their level of skills.

ICT supported the exam according to most students because they thought it to be easier to complete the exam. This was evident in their responses to E2 survey items where on average 75% either 'strongly agree' or 'agree' to all the E2 items (a to k). In addition 95% of students scored above the midpoint of 2.5 with a mean value of 3.0 and SD 0.5 on the eAssess scale, which reflected their perception of the efficacy of the computer-based exam. In addition, comments from the open response items were made by students such as, '*… it was quicker and easier to design, ... easy to design and make multiple copies fast* (NA)*; … able to use software to help in reflecting on our designs* (OA)*; ... easy to use and easy to edit* (VA); and *... I am better at using the computer for designing and the computer has helped me* (ZA).

All students considered ICT helped them in completing the digital portfolio, believing they improved the presentation of their work. This allowed them to showcase their production in digital forms and in a dynamic dimension. They signified that it was easier to store and locate their work quickly, thus making revising and editing more efficient. The high scores from the eAssessP scale supported this assertion with 95% of students scoring above the midpoint of 2.5 on a scale of 1 to 4 where 1 represented strongly negative and 4 represented strongly in favour. The mean value was 3.2 and SD of 0.6, showed the positive perception of these students towards completing the digital portfolio. Their open responses were supportive, '*... was neater than my handwriting* (NA)*; '... easier to locate and edit your work at one location* (XA*; and '*... easy to upload your pictures'* (ZA). Therefore the convenience of the digital portfolio was an important aspect for students this being also an indication of the value for them and pride they had in the AIT course.

All students believed that ICT should be part of the AIT course partly because they valued ICT and perceived that ICT supported them in showing the quality of their work. They felt

that ICT use would enhance the course and more authentically support the learning tasks they performed. This was evident from their open item comments such as, '*… faster way to complete my learning tasks with the help of computers (NA);,* and *'able to show examiners what we can do in practical tasks with computers' (ZA).*

AIT Teachers – Attitudes

All teachers wanted students to use ICT in the AIT course because their students enjoyed the lessons presented with the support of ICT. They were also keen to align students' performance in the task activities with ICT support. They felt the digital environment in which they taught could enhance curriculum delivery and liked the opportunity to use ICT with their students. This was evident from the responses in the initial teacher interviews, where they indicated having access to ICT in the classroom and enjoyed teaching with ICT.

All teachers approved of ICT use in the exam with the assessment tasks because they agreed computer use had helped their students to be more creative in completing the exam tasks. The students in this study could show their best work with ICT support. They also supported the interactive use of ICT in the exam, thinking students reacted positively to practical exam. Their responses to the post-interview questions were indicative:

> *… the format of the AIT exam was appropriate for the course because a practical course required a practical exam, … there was a need to convince the Curriculum Council of the benefits of an ICT supported exam (XA).*

> *… the assessment tasks in the exam were good because students felt that computer applications were useful in supporting the exam tasks. (VA).*

> *… the assessments task in the AIT exam seemed to provide students an opportunity to use and learn new ICT skills (OA).*

> *… overall the assessment tasks in the exam were fine and suited a stage 2 AIT course, … perhaps great potential for this from of exam to flow onto other subjects (NA)*

> *… a practical exam should be the way forward (ZA)*

All teachers preferred students to be completing a digital portfolio as a form of assessment in AIT because they felt students were most comfortable with digital portfolios as this was the type of task normally attempted in their weekly classes. They were elated that their students were competent with a digital portfolio, being assured their skills could help them in

completing the design brief for the assessment. Their responses to the questions in the interviews were very encouraging: … the tasks were fine, liked the fact that the digital artefacts for the portfolio submission, allowed students to choose a task that they completed in class, students loved the activities particularly the production of a DVD (ZA).

> *… practical course would be appropriate to have practical assessments for example creating digital portfolio (XA).*

> *… they enjoyed the digital portfolio more than the exam as they were familiar with it; they were able to show their quality work in one organised folder (VA).*

> *… the digital portfolio was more favoured by students, had spent more time motivating students with digital portfolios (OA).*

> *… most students were more positive towards the digital portfolio because they were familiar with it (NA).*

AIT Teachers – perceptions

All teachers in the case study groups agreed ICT should be part of the course, beleiving the course components within the AIT curriculum itself are ICT rich in nature and appropriate for application in learning technologies. Their sucessful practices in teaching AIT influenced their perceptions. This assertion was portrayed in the responses of two teacher interviewees:

> *… students like using computers in class they did all there researches on the Internet (NA).*

> *… students seem to be more engaged with the task on hand when completing learning tasks (VA).*

> *… AIT is a practical course; therefore ICT would seem the appropriate tool for students to meaningfully show the processes to their products (XA).*

All teachers believed their students to have good ICT skills and that generally they were savvy in using digital tools, and they were accustomed to, and communicated efficiently by social media in their schoolwork and play. Their conclusions that students had good skills were evident from their responses during the pre-interview, wherein all teachers confirmed their students enjoyed and responded positively in a rich ICT-based learning environment:

> *… when in a computer lab the first thing they do is to surf the Internet (NA),*

> *... they enjoyed using the Internet for research rather than the Library with books (XA and OA), and*

> *... it was easy for them to use the computer because they had good keyboarding skills (OA).*

All teachers agreed ICT helped their students with the exam and was reinforced in their responses during the post-interview Their responses were apt to *Q1 concerning,* 'their thoughts on the assessment task overall'; Q3 regarding reactions to, 'what were their students reactions to the activities' and (5) which asked, 'were you surprised by the performance/attitude of the quality of work produced by their students'. All teachers' perceptions were relatively similar as indicated by such comments regarding Q1, 3 and 5 respectively as:

> *'... students responded well to doing the design brief with computers and were able to show real-time interaction in some areas of their webpage linkages, they could also upload to 'My Webpage' on the school's intranet which all students used,* (XA)'

> *'... students felt a sense of 'realism' and 'readiness' because they could pace themselves to the activities especially doing the digital portfolio,* (VA)'

> *'... in some cases teachers were surprised because their students exceeded their expectations, mostly teachers were pleased'.* (summary of all teachers).

All believed the digital portfolio was an appropriate part of the assessment process, concluding the use of digital forms of assessment would complement the creation of a digital portfolio in which students could organise, store, share and retrieve their work efficiently. All teachers had positive views about the appropriateness of using digital portfolios for assessment. This was also evident from their responses to the first interview question *Q5d,* concerning the proportion of time they like to see their students using computers in class. Their inclination was that their students should employ computers for up to 100% of classs time believing their students could be more creative with their work resulting in an acceptable standard of outcomes, wherein teachers could more closely monitor their application of ICT in such endeavours as digital portfolio.

The majority of teachers affirmed their students to be confident in undertaking the digital portfolio, but less so the exam. They agreed their students were already doing digital portfolios in their normal classes, had developed appropriate skills, and were more confident

and comfortable with the digital portfolio compared to a computer-based exam. This was evident from their responses to the first interview question, Q5a, concerning usage in their classroom. All teachers indicated computers were employed by students performing regular task activities such as:

> *... projects, computer-based quizzes and multi choice testing (NA),*

> *... completing tasks/assignments, research and PowerPoint for presentation (OA),*

> *... research, reports and projects (VA),*

> *... assignments, assessments computer-based tests and programing (XA)*

> *... graphic design, image manipulation, video editing and programing (ZA).*

Similarities and differences in attitudes and perceptions towards ICT in assessment

This section compares teachers' and students' attitudes and perceptions of ICT use in assessment between the two courses, and discusses similarities and any variations that occurred between the two.

All students in the case studies used computers for some or most of their work in class. The Engineering Studies students were timetabled in a workshop and the AIT students in a computer lab. The Engineering assessment involved a computer-based design exam. Two digital forms of assessment were considered for the AIT course, digital portfolios and computer-based exam. Students from both courses indicated that they had skills with ICT and ample opportunities to use ICT to support assessment. Their positive attitudes and perceptions of their skills, coupled with access to ICT use, was a positive factor in their acceptance of the research on ICT in assessment.

Although students in both courses were relatively similar with regard to computer use, their perceptions varied slightly in use and skills. The AIT students perceived themselves to be a little more attuned and savvy with ICT in general because they had greater access and use scoring a higher mean in the SCUse scale. For the AIT course digital technologies provided the content for the course as well as pedagogical support. Relatively speaking, AIT students spent a little more time using computers each day, compared to Engineering Studies students. However all students felt confident with computers and liked using them. Overall both Engineering and AIT students indicated a high self-assessment of their computer skill with both of them having a mean of 3.2 and 3.3 on a four-point scale.

Both groups of teachers' attitudes and perceptions tended to highlight the separation between teaching-learning process and the evaluation process. They believed that practical performance-based assessment tasks such as Engineering Studies and AIT courses could not be meaningfully measured by conventional pen and paper-based assessments. Their responses from the two interviews were typified by, *'... the Engineering course is a practical course and student were involved in practical projects'* (WE), and the AIT course is an *'... Applied course'* (XA). This resonated to some degree because the two course syllabusi incorporated a significant degree of practical components. These components were expected to familiarise students with the technology process, thereby stipulating a product-based curriculum. Yet the external evaluation process was a paper-based process; hence teachers' perception of separation of the theory and practical components of the course.

All teachers in both groups had access to ICT it in a variety of ways with their students. Some may have been early adopters of ICT for assessment; however most just valued the unique characteristics of the digital learning environment not necessarily for assessment. They believed that digital assessment should be a requirement for appropriate assessment in the courses of study both in Engineering Studies and AIT. In addition they considered the focus on ICT-based learning environment along with self-belief in the value of using ICT was partially crucial to the support and successful use of digital forms of assessment in schools (Kim et al., 2013).

In general, all knew intuitively that the use of traditional assessments did not adequately measure student outcomes in their courses, because these methods had failed to assess the production phase of the technology process. The intention of the current Engineering Studies and AIT curriculum is to provide 'opportunities for students to develop knowledge and skills relevant to the use of ICT to meet every day challenges' (Curriculum Council of Western Australia, 2009, p.3). In most sessions at school, students spent the most of their time developing solutions and focusing on production. The process component of the syllabus stipulates a weighting between 50-70% of the assessment marks. Clearly the intention of both the Engineering Studies and the AIT courses are to be product focussed and the current external exam does not match the intended assessment of practices.

Feasibility of implementing digital forms of assessment

This section focuses on subsidiary question three: *'What effects on the feasibility of digital forms of assessment do differences in student attitudes and perceptions in AIT and Engineering?'* This will draw on the results from the previous chapters, namely the data collected and analysed from classroom observations, student forums and student surveys. The feasibility framework in Chapter 3 (see Table 3.5) adapted from Newhouse et al. (2009), together with these data sources will be used to support this discussion.

A summary of findings was compiled from the five Engineering Studies and AIT case studies on students' attitudes and perceptions so asto address the second subsidiary research question. The findings were organised using the dimensions of Manageability, Technical facility, Functional operation and Pedagogical alignment. Each aspect included a summary of the constraints and benefits for the form of assessment used in the context of the specific case. These findings are now discussed in turn with respect to each dimension of the feasibility framework. Assertions for each of the dimensions will be discussed and will be supported by evidence from the data analysis. This section will then conclude with a summary of findings for subsidiary questions one and two and then combined to answer the overarching research question. This will form the basis of discussion leading to the conclusion of this chapter.

DFA in Engineering Studies course

This section discusses the four dimensions of the framework in the Engineering Studies context from the results of the previous chapters.

Manageability Dimension – Engineering

Some students perceived they were capable and experienced with using ICT in exams, thus teachers should find facilitating these types of exams more manageable. This assertion was supported by the fact that 84.5% students indicated that they did not need much time to get used to doing design projects on computers with 98.8% assuming it was easy to use the computer when completing the exam in this study. These students were more likely to be more engaged and compliant with the exam process because they had the capacity to understand the purpose of using ICT in design projects, this was reflected in the findings in this study about students' capabilities and experiences and their positive perceptions towards ICT. This should assist teachers in facilitating the exam process and are likely to ease the manageability of using ICT in an Engineering Studies exam.

Most students believed they enjoyed doing the assessment task and welcomed ICT supporting assessment; this positive attitude should enable teachers to plan and organise assessment tasks better. It is well documented in educational research circles document attitudes and perceptions to be an important element towards getting students accepting and implementing a given scenario (Barak, 2014; Barak & Ziv, 2013). In this case their positive perception towards using ICT to support assessment was important. The student survey supported this assertion wherein 98.8% believed computer use made schoolwork much easier, and 74% enjoyed using computers at school. A high mean value of 2.6 in the Attitude scale also further indicated their positive attitude towards using ICT. This positivity should help teachers to better plan and organise digital forms of assessment better as there is a strong support base for employing ICT to support assessment in Engineering. This positive attitude would be highly likely to increase the manageability of the exam, making it more feasible to implement.

Technical Dimension – Engineering

Most students were confident with using a range of digital devices in the exam. However, a few students had problems with using the webcam indicating they lacked the skills required in the adjustment of the focal length of the camera to provide a clear enough image. Their concern was partly due to their unfamiliarity with the use of this device, especially as it was hand-held. The camera not being fixed led to the possibility of 'camera shake', which would not result in crisp representations of their design. This was evidenced from observations and student forums comments like, '… because it was the first time using this device on a computer, I was not prepared'. On the whole most students responded well to the style of the exam because they were able to overcome the minor technical issues successfully and operate the range of digital devices in the exam, thereby completing it. They also preferred this form of assessment to continue especially with open items), ths showing support for ICT use, and their willingness to accept the challenges of working with digital technologies. Their positive attitudes, assertions of confidence, and their preparedness to overcome technical issues were positive indicators of support for a computer-based exam Engineering Studies.

Because most students believed themselves capable of applying the range of software applications in the exam for the design project, they were likely to be able to overcome software technical issues in assessments. This assertion was supported with survey items Q10c, d, and f in which over 86% reported to have used a range of Microsoft Office suite for doing their assignments at school, including the exam for drawing and word-processing. Most

students completed the exam, agreeing that ICT assisted them to showcase the quality of their work. This positive attitude derived from a student forum discussion would likely reinforce their notions of the value of ICT. They were sure ICT assisted them in accepting the extent to which computer technology could support the assessment processes. Comments in the open items, where most students extolled their ability to show their best quality work because of ICT. Such positive perceptions tended to sway students more towards self-reliance when addressing any technical issue arising and even collectively overcome challenges presenting themselves occasionally when using ICT. The positive attitudes and perceptions of students were likely to increase the technical feasibility of the exam.

Functional Dimension – Engineering

Most students perceived ICT to be relevant to engineering, therefore believing it was valid for assessment purposes. This was evident from survey data from this study, such as students' perceptions of the validity of the assessment inferred from responses to certain items in the survey and open items, for example, 'Overall it was better doing the exam using a computer compared to a paper-based exam' Students' responses to survey E2 items were aggregated into the eAssess scale thus giving a mean value of 3.2 on a scale of 1 (strongly disagree) to 4 (strongly agree). This would attest to a strong opinion of validity of the construct for the course, thereby supporting ICT use for assessment in the Engineering Studies course.

Most students believed the use of digital forms of assessment was valid because they were capable of doing the engineering design project using the computer. They considered the use of ICT in undertaking the design project was most apt and appropriate,they considered it to be a fair and authentic means of measuring their performance. They were able to develop and design their ideas easier with the help of a computer. This assertion from survey items in this study concurred that ICT supported the validity of the use of digital forms for assessment. Students affirmed their capability in using digital technologies to develop and design their ideas in the assessment. This was consistently represented in their remarks to the open items 'the two best things about doing the Engineering exam using computers'.

Most students thought the computer was a valid tool for modelling the design project and this enabled them to demonstrate quality work; therefore they needed to apply ICT for their work in assessments. This assertion was supported by almost 81% of the students who indicated that the computer was record their design and modelling, and 84% either strongly agree or agreed that overall, the computer was a good tool for designing and modelling. Generally

most students accepted that the structure and process of the exam measured the task outcomes, and were meaningful to the assessment task. They agreed a good range of materials was provided for modelling in the exam. Students' positive perceptions of the validity of the exam were further substantiated by high scores in the eAssess scale. This scale had a mean of 3.2 and SD of 0.5, with an alpha reliability coefficient of 0.9. These positive attitudes towards, and perceptions of embracing the use of ICT for assessment by students students indicate that it should be endorsed because there is a need for it.

Pedagogic Dimension – Engineering

Most students were motivated by the use of digital technologies and enjoyed using them in the course; in particular they believed ICT should be focus on their learning and assessment. This assertion from this study was supported by discussions with students and teachers and visits and observations of classes in action. Therefore aligning digital pedagogies with contemporary students' learning styles is becoming a moral imperative to engage students in learning and in so doing achieve high quality outcomes/practices in Engineering Studies. Most students demonstrated their full potential using the computer and its employment was an essential component in demonstrating the quality of their outcomes in Engineering Studies. They responded positively to E2 items which refer to the ease of accomplishing the design project, and were generally positive regarding their experience and knowledge with computer technology expressed in survey items (Q5 to Q13). This inferred that that were passionate about using meaningful digital technologies and digital pedagogies to enable high quality learning outcomes through the integral use ICT. This is also an issue recognised widely at policy level (DETWA, 2013).

Most students liked using ICT to support assessment and learning, feeling a sense of realism. The findings from opened items this study found that Engineering students perceived that engineers used ICT in their work in the 'real world' to solve 'real problems'. Thus their perception of solving real problems using ICT made it relevant, appropriate and real in engineering terms as evidenced by their remarks from the open response items.

The majority of students enjoyed using ICT because they perceived it as providing the opportunity to communicate using sites like MySpace, Facebook and YouTube, which would encourage them to share and learn collaboratively. This contention was supported by their responses to Q10 wherein 86% of the study group indicated they communicated using social media sites, thereby acknowledging they had enjoyed and shared 'commonalities' in school

work and play, and ICT was an important part of their life already. This was evident from the findings in this study when students realised ICT could lead to valuable learning and pedagogical strategies matching classroom dynamics could become more interactive and stimulating, this also concurred with (Kennewell et al., 2008; Mishra & Koehler, 2006).

Because Engineering Studies classes were normally conducted in purpose-built workshops equipped with machinery and mechanical tools an assumption existed that 'Engineering pedagogical practices' were already more practical than in other subjects. Although students use mechanical tools in their learning tasks, opportunities opened up for them to access computers. However, some students professed to being less familiar with a computer-based exam as evidenced by their responses to the survey in this study (Q4), 'How much different was this to how it used to be done? This question referred to the use of ICT in the exam compared to their normal learning practices in the workshop.

A dichotomy of beliefs appeared between students and teachers in terms of actual and preferred use of DFA as represented by students' responses to forum questions and the initial teacher interview question (Q1a), 'Do the students in your class use computers for assessment purposes?' The responses to these two questions did not align regarding students' and teachers' perceived DFA use in the class. Findings from student forum representatives alluded that using DFA was very different to the way they were assessed in class. They indicated that using computers in the exam changed the process of assessment, for example, from a paper-based to a digital form. However, most teachers signified their students used computers for 'assessment purposes' as evidenced from their responses to the teachers' first interviews, Q4. Their interviews revealed they appreciated the value of digital forms of assessment, and may have explored using some on-line quizzes with their students further, and wished to realise ICT supported assessment in their courses. However most used ICT in teaching and presentation and not necessarily use digital forms of assessments in class activities. CBAM mappings evidenced this wherein most teachers were shown to be at the earlier stages of using ICT to support assessment.

DFA in AIT course

This section discusses the four dimensions of the framework in the AIT context of the results from the previous chapters. Two main forms of assessment were investigated: a digital reflective process portfolio and a computer-based performance exam.

Manageability Dimension - AIT

Most students were of the opinion they were capable and experienced with using ICT in the exam; thus teachers should be assisted in planning and organising this type of exam making the use of ICT to make assessments more manageable. The general perceptions analysed from E2 items and teachers responses to the post-interview is revealing. Both students and teachers agreed the assessment tasks for the exam were favourable and capable of ICT supporting the AIT exam. Comments from all teachers in the AIT cases in this study alluded to the exam being centred on their opinions of appropriateness and the ease their students experienced in using ICT in completing the assessment tasks. All these were powerful comments implying the need for ICT use to support the AIT exam as evidenced in this study.

The vast majority of students enjoyed doing the digital portfolio, agreeing that using ICT supported the tasks, and this would likely assist teachers in facilitating the digital portfolio. This study found that evidence for a strong endorsement of students' positive perception of completing the digital portfolio; it was also proven endorsement an acceptance and support of this form of assessment by teachers' aid in the facilitation and management of the digital portfolio in AIT in this study.

The majority of students affirmed they were experienced completing the portfolios; therefore this should help teachers improve management. This assertion was supported by most teachers' responses in the post-interview, agreeing that their students were experienced in portfolio work. Students understood the requirements for doing the portfolio because it was part of the semester assessment. Clear evidence from student survey that doing digital portfolio tasks could increase manageability for teachers because efficiency of emerging digital technologies in management practices in education.

Technical Dimension – AIT

Most students were confident using a range of digital devices in the exam and portfolio, such as, computers, digital cameras, video cameras, iPods, laptops, game consoles, mobile phones and webcams. Therefore ICT use should be readily integrated in learning and assessment, as students are better able to overcome technical challenges. This assertion was supported by the researchers' observations, student surveys and teacher post-interview responses in this study. The common theme herewith was no critical technical problems were present in the exam. Any minor technical issues such as, computers freezing necessiting a restart, and a call for

extra exam time were easily rectified during the proceedings. Students easily overcame some minor tweaking with sound cards and volume control when needed.

Almost all students affirmed they were skilled in using a range of software applications in doing the exam and the digital portfolio, for example Word processor, Spreadsheets, Databases, PowerPoint, Email Computer file management, the Internet, Webpage authoring, Digital photography, Image editing and Video editing. This was evident from student survey item (Q13) wherein most students were confident with a range of application software, such as, Office 2007/8, Adobe and CS3/4, and various graphical software packages like CAD and Auto Sketch. They were also capable of running these applications for all the exam and portfolio tasks, in this study. This strongly emphasising the need to use ICT in fulfilling students' expectations of a digital environment. The positive attitudes and perceptions of students towards software application and their skill with these devices increased the technical feasibility of implementing the exam and portfolio.

Functional Dimension – AIT

All students signified ICT to be relevant to AIT, therefore believing it to be valid during assessment. Students' perceptions of the validity of digital assessment could be inferred from responses to survey items providng a measure of the validity of the the use of ICT-based exam as an assessment during this applied course. This is evidence to support the functional demension and capability of ICT supported assessments.

Most students tended to favour completing the digital portfolio; they had a positive attitude to this digital form of assessment. Findings in this study alluded that the majority of students favoured completing the portfolio compared to the exam because, to them, it was 'more realistic' for a practical course when measuring practical performances this was reflected in their responses in the opened items used in this study. The procedure was not tightly constrained by time, thus allowing more flexibility to explore and to create their assessment tasks. They had positive beliefs, trusting in the authentication of a practical, performance-based over a paper-based assessment. This sentiment was reflected in most of their comments in the open items concerning the best things about doing the AIT portfolio. These positive attitudes and perceptions of students' skill in ICT use demonstrated their beliefs in the efficacy of both forms of examination would increase functional feasibility.

Pedagogic Dimension – AIT

All students agreed using a computer in performing assessment tasks was engaging, giving them confidence that the computer enhanced their learning. This was evidenced by their positive perceptions extrapolated from the E2 items where the common themes were, '… good, helped and better with a computer-based exam'. Almost all students affirmed the computer was useful for assessment tasks, confident they had the skills necessary. They considered the skills needed were typical of those they acquired and used in class activities, thereby inferring the close alignment of ICT use in the exam with ICT applied in typical class activities.

Most students enjoyed their course work because employment of ICT was involved. This was appropriate for the course, so they believed ICT should be employed. This assertion was supported in this study from the responses from the survey wherein students exhibited highly positive attitudes to their assignments/projects on computers. The AIT course was conducted in an ICT rich environment and all students had access to ICT in a computer lab. They were accustomed to ICT for class activities, enjoying the opportunities to practice and extend their skills.

Nearly all students and teachers considered the AIT course concerned the practical employment of ICT; they considered this to be relevant to the curricular context and should be employed in the course. This assertion was supported in this study by both students' and teachers' believing the key reason and rationale for the existence of the AIT course was to demonstrate the technology process, and understanding information and communications technologies, and quality of information solutions. This also clearly specifies the value and importance of practical skills (Curriculum Council of Western Australia, 2009).

Most respondents were motivated by the use of digital technologies in both the exam and the digital portfolio; therefore they expected to learn better using ICT. This assertion was evidenced from results of data analysed and recorded in the previous chapters of this study, which indicated all students believed the application of digital technologies enhanced their work in both the assessments, thus being implicitly linked to improved student learning outcomes with better use of ICT. In both the eAssess and eAssessP scales measuring students' perceptions of the efficacy of the exam and the portfolio, both means 3.0 and 3.2 on a scale of 1 to 4, respectively strongly pointed to enhanced learning using ICT.

The vast majority of students in this study affirmed deploying ICT to support assessment and learning was relevant to the course and should be utilised throughout. Their comments made in the forum and in response to open items were summed by one respondent, 'AIT is an applied course therefore using computers is relevant'. Generally students remarked that the portfolio and exam with ICT support was useful and suited their course work. Generally the study cohort enjoyed using ICT in their learning and collaboration with peers; this attitude would pertain across all their subject areas. This was evidenced in their notions of ICT access and computer use, wherein most student have Internet broadband access 24/7 (Q6), and they spend an average 75 minutes using computers each day at school, as well as having access to computer most days at home (Q7). Almost all students used sites like MySpace, Face and YouTube as an answer to the communication item (Q10f). Such positive attitudes and perceptions of students towards their learning process with ICT support were likely to increase pedagogical feasibility.

Summary

This chapter addressed the overarching research question by discussing the subsidiary questions in the light of the study's findings. The key points of this discussion are now summarised directly in accordance with the research question, thus leading to the presentation of conclusions in the final chapter. The study's research question was:

> *In what ways do the perceptions and attitudes of teachers and students towards the use of ICT in learning affect the feasibility of using digitally based representations of student work output on authentic tasks to support summative performance assessments for the Engineering Studies and AIT WA courses?*

The main concept of the research question concerned the attitudes and perceptions of teachers and students' towards the use of ICT in particular student learning. Currently students' and teachers' views of ICT tend to focus on test development, the composition of closed questions, the development of assessment rubrics and statistical analysis of cumulative data for variety of teaching and learning needs (Donoho, 2000; Popham, 2004). This held true for the Engineering Studies group of teachers as 'mechanical users', as evidenced from CBAM mapping in this study. The study found not many Engineering Studies teachers consciously embarked on using digital Forms of assessment. The CBAM mappings showed most teachers

in both groups were skilled in ICT use, but not in assessment and at best were 'mechanical' users.

Digital portfolios were commonly used as part of the assessment in the AIT course. Teachers in this group were somewhat more familiar with 'digital assessment literacy'. Teachers in both groups could be considered as early users and developing skills in this area of *'digital assessment literacy', as* defined by Stiggins (2002). According to Eyal (2012, p. 37) "... an assessment literate teacher is one who understands what and how assessment methods increase the motivation of learners and include them in the learning process".

Both groups of teachers and students indicated that they believed ICT support was needed to drive the curriculum in both Engineering Studies and AIT, thus these attitudes and perceptions should assist the manageability of digital technologies in support of the learning process. The majority of teachers involved in this study were concerned about the current lack of alignment between students' learning tasks and the relevant means of measuring students' study outputs. This attitude concurred with most teachers' belief in the need for a reliable assessment method, certainly to include digital forms, to authenticate students' achievements in terms of the real world use of computer technology as evidenced from their results in both teacher pre- and post- interviews. Teachers observed there to be a need to align the learning process and the assessment process in order to enhance validity and reliability; they believed in the efficacy of the digital portfolio. These positive perceptions of validity and reliability would likely help the feasibility of digital forms of assessment in the examination of students' achievement of learning outcomes.

Regarding the manageability for Engineering Studies and AIT, slight variations between the two courses were apparent because the mechanics of tasks activities and location/types of teaching and learning environment differ in content and nature. However, both of these courses required students to demonstrate the technology process and show they can apply their understanding of ICT to solutions. Therefore, for each course there was a common assessment task that consisted of a number of sub-tasks.

In the Engineering Studies exam, the design task project was broken down into a number of timed activities and students were paced through each activity recording their input in the form of a digital portfolio. Most students believed the Engineering Studies exam to be a 'new way'; they indicated in the forum discussions that the procedure was different from previous assessment/exams. They claimed unfamiliarity with the method of assessment, they were

confident a little time only would overcome this unfamiliarity with the process. This positivity of perception would greatly increase the manageability of the exam. In addition, teachers were very supportive of the assessment task approach, affirming it complemented the nature of the course. This study found that, with the highly positive attitudes and perceptions from both students and teachers, it was possible to implement design project processes from developing, recording, evaluating, designing and modelling with little or no significant problems in all the Engineering Studies case studies.

The AIT exam consisted of two assessment tasks, the tasks developed for the digital portfolio and the computer-based exam; both were intended to be authentic and reflect typical real world applications of technology. The digital portfolio had considerable flexibility for students and teachers, allowing them some flexibility in the setting up and implementation of the assessment. The teachers largely facilitated the digital portfolio over a period of six weeks in their classroom as learning tasks for students. The students, supported by their teachers believed the digital portfolio enabled a dynamic dimension in the presentation of their work in terms of scope for interactive display. They felt that it allowed them to demonstrate the richness ICT brought to their learning and assessment processes, thereby enhancing the value of their work. Their positive perceptions of this form of assessment would likely enhance the manageability feasibility of the computer exam and the digital portfolios. Generally students and teachers perceived the tasks for the digital portfolio very favourably and more favourably than the exam. However some challenges to the degree of flexibility allowed in setting up hindered compliance to the default design brief wherein teachers collaborated with students. Perhaps this was a reflection of the real world which operated this way; therefore it could be argued the restriction was as 'authentic' task. However, most students felt comfortable with the technology whether using a desktop, laptop or other similar device thereby tending to increase manageability.

The computer-based exam was considered valid by students and teachers and supporting the perceptions given in various devices used to elicit opinions. Most students believed it better to employ computers for the exam they enhanced validity in the measurement of their work. All teachers concurred with this statement, considering the exam appropriate and excellent because their students were able to showcase their best quality work. They perceived a computer-based exam as enabling new pedagogical strategies, matching of performance-based tasks, and stimulation of reflection.

The next chapter discusses the conclusions made regarding the implementation of ICT to support digital forms of assessment, and ICT as challenging aid in teaching and learning.

CHAPTER EIGHT:
CONCLUSIONS AND IMPLICATIONS

This chapter brings together the findings from the study which are presented in terms of the research question and then draws out conclusions. Following this the limitations and implications of the study are discussed, and finally the chapter provides recommendations for current and future practice and policy for teachers, school leaders and school systems.

The results of this study permit conclusions to be drawn with respect to Engineering Studies and AIT students' and teachers' attitudes and perceptions regarding using digital forms of assessment. The aim was to encourage a shift from a paper-based mode to a digital format of measuring practical performance process assessment tasks. However, such a change is potentially relevant for many areas of curriculum in schools outside of Engineering Studies and AIT. Within this chapter the case will be made for the replacement of the current pen and paper based assessment practice for Engineering Studies and AIT courses with digital forms of assessment.

Assessment is said to drive the curriculum; thus the assessment of practical performance-based courses can be better achieved with ICT support. Crucial to the effective use of digital technologies to authentically represent work outputs for assessment are students' and teachers' attitudes and perceptions towards the ICT being institutionalised. Most current research literature on teachers' attitudes and perceptions towards appropriate ICT use encompass the discussion of domains of technological, pedagogical and content knowledge (TPACK). The content knowledge from the curriculum in both Engineering Studies and AIT requires a significant amount of practical work, with students being required to demonstrate these outputs in the learning outcomes. This practical work should be assessed in such a manner as to reflect the stated intentions of the curriculum content. Present assessment in both Engineering Studies and AIT courses lacks this alignment and authenticity, yet pen and paper remains the dominant force driving assessment. Students' and teachers' perceptions in this study reflected the need for, and provided a rationale to improve, the validity of the assessment of practical performance through exploring digital methods of assessment to bring about the alignment between assessment, curriculum and pedagogy. Masters (2013) also flagged a similar notion when he argued for tests designed to measure key learning in schools while ignoring some key areas, then attention to those areas by teachers and schools is reduced. Clearly, students' learning can no longer be restricted to pen on paper tasks;

therefore, digital forms of assessment are a critical alternative for both of these courses. This research has shown that a change to digital forms of assessment would be supported by both students and teachers for these two courses as evidenced by their attitudes and perceptions toward using digital technologies deduced in this study.

The research question for this study was:

In what ways do the perceptions and attitudes of teachers' and students' towards the use ICT in learning affect the feasibility of using digitally based representations of student work output on authentic tasks to support summative performance assessments for the Engineering and AIT courses?

The three key concepts within the question are *attitudes and perceptions of ICT use in learning, feasibility of digital forms, and support summative performance assessment.* Conclusions relating to each of these aspects will now be presented. The three subsidiary research questions were addressed in the previous chapter, thus the following discussion builds on that discussion.

Supporting Summative Performance Assessment

Students enrolled in the Engineering Studies and AIT courses of study must sit an external assessment, the results of which are used also to moderate scores from the school-based assessments contributing towards the Western Australian Certificate of Education (WACE). The purpose of assessment is to identify competence achieved by students in all aspects of the curriculum. The aim of this study, however was to identify the feasibility of particular digital forms of summative assessments for these two courses. This research has shown the manner in which both of these forms of digital assessment to be appropriate and useful, having the potential to meet the validity, reliability and fairness requirements of summative assessment. The study included seeking the perceptions of students and teachers towards the design and implementation of computer technologies to support forms of assessment that may improve authenticity and validity. Importantly it aimed to gauge teacher and student perceptions as to how well the digital forms of assessment deployed in this study matched the course content.

Two digital forms of assessment were used in this study, a computer-based production exam and a digital portfolio. The computer-based production exams for Engineering Studies and AIT involved students sitting at computer workstations to create a product or design. The

focus was on the use of digitally-based representations such as, images, audio and video recording of performances. The digital portfolio was the cumulative collection of aspects of a project captured over a period of time. These were examples of ways digital technologies could enhance summative assessments, including validity and fairness, for students enrolled in AIT and Engineering Studies.

The computer-based production exam for Engineering Studies involved a scaffolded series of activities which took the students from a design brief to the construction and evaluation of a physical model over a period of 3 hours. The e-Scape system was used in the Engineering exam as the tool to design and present the task to students. Students used peripheral devices such as webcams and audio recorders for voice and videos to support task outputs.

The portfolio for AIT consisted of a product-process document and two other digital artefacts. A default design brief with guidelines defined the structure of the digital portfolio and students were given time in which the work was to be completed. The teacher implemented the design brief for the AIT digital portfolio during class time over four weeks. In this study, digital technologies employed in the AIT portfolio typically included a combination of desktop computers, the Internet, an office application suite and a graphical design software package. The MAPS online portfolio software supported the manageability of assessments by recording all students' inputs in the form of a digital folio. Students were to upload their portfolio files into the MAPS online system. These digital portfolios provided a cumulative collection of students' work which was then assessed.

The AIT computer-based production exam and digital portfolio were a mixture of design, production and reflection. This was the intent of the course outline for Stage 2 AIT, which states, 'the focus is on information and communication technologies in business' and, 'students design information solutions for problems encountered in these contexts and understand the social issues inherent in work practices'. The course within these contexts makes direct reference to the use of digital technologies, that is, word processing, publishing, presentation and financial data management, and validation of data text, numerical and image-based integration, and the presentation of these data.

For the AIT course, digital technologies form part of the content and thus performance is related to using these technologies to demonstrate capability in their use. Therefore, the computer-performance-based exam and the digital portfolios were considered to align with the aims of the course and pedagogy, implying that assessment must include students using

digital technologies. The methods of assessment used in this study enhances external summative performance assessments due to the appropriateness of the digital technologies employed to ensure their alignment with the course requirements.

This study made it evident that the use of digital technologies underpinned the summative assessment of the process, supporting higher-order thinking, such as decision making, reflection, reasoning and problem solving. Both the eAssess and the eAssessP scales from the surveys of students indicated a strongly positive perception of the appropriateness of ICT in the summative assessments. The transition to digital-based performance assessment has a number of significant advantages including reduced costs, increased adaptability for users, opportunity to collect process data on student performance, and the provision for real-time feedback for performance assessment. This performance assessment tended to provide a closer alignment between assessment, curriculum standards and instructional practices, particularly with regard to eliciting complex cognitive thinking (Lane, 2004). Therefore the two forms, computer-based exam and the digital portfolio, clearly supported summative performance assessment in the Engineering Studies and AIT courses.

Each form of assessment had relative strengths and weaknesses, for example, the computer-based exam, with its concise and structured format was implemented more consistently than the digital portfolio, wherein teachers' interpretations of the requirements differed. Work produced during the exam process was entirely student centered whereas for the portfolio, collaboration and assistance could not be discounted. Due to the nature of the digital portfolio task in which the collection of output and evidence happened over from a prolonged prolong period of time, the overall judgement of the student results could be questioned in terms of validity because the possible variation in consistency of requirements between schools. However, a strength is that the digital portfolio allowed students to demonstrate a wider variety of skills than the exam naturally allowed.

Both the Engineering Studies and AIT exams allowed only a narrow range of performance to be demonstrated due to the time constraint; this was recognised by students by making such comments as, '… the exam worked well and as an assessment task, would prefer more time for the exam'. In addition, some minor technical difficulties occurred during the exam but none of these prevented completion. For the portfolio, the extended time frame meant that any technical difficulties could be resolved without impacting negatively on the assessment.

Attitudes and perceptions of ICT use in learning

This section focuses on conclusions about the attitudes and perceptions of students and teachers towards ICT being employed for assessment, learning and teaching. This study focused on their attitudes and perceptions about fundamental shifts toward digital forms of assessment in their courses. This shift did take students and teachers into new ways of teaching and learning but is likely to challenge their attitudes and perceptions concerning learning, teaching and assessment, and their roles as students and teachers. For example, their perceptions of ICT-related knowledge and skills is likely to be challenged, especially the capability of ICT, and the manner with which relates to teaching and learning and about learning itself.

Conclusions about attitudes and perceptions are now discussed for each course separately

Engineering Studies course

The attitudes and perceptions of students and teachers in Engineering Studies are discussed in relation to digital assessment and ICT skills and learning.

Digital Assessment

Typically, students enjoyed manipulating the digital assessment tools provided by the study. The majority of them perceived the assessment task to be authentic, engaging and meaningful to their course. They recognised the connection between theory and practice and felt the task to be authentic in that it reflected 'real world' practices in the field of engineering. This positive perception and belief was reflected their attitudes towards the endorsement of similar forms of digital assessment for employment in future Engineering Studies courses.

Most teachers were of the opinion that the digital form of assessment used in the study provided authenticity in judging students' performance. All teachers considered the assessment task to be fairer, reflecting students' ability better than a paper-based exam. Most of them made statements such as, 'From what I saw and from what I heard from students the situation sounds to be appropriate', indicating their belief that this form of assessment had great potential to be applied in all practical subjects. This positiveness displayed in their beliefs would likely ensure the feasibility of digital forms of assessment in the Engineering Studies course.

ICT Skills and learning

Generally, Engineering Studies students perceived their lacking the ICT experience required by the exam, expressing their contention of needing more time using computers in the course. However, they were not daunted by this unfamiliarity because they could overcome this weakness by spending a little more time with ICT. They believed in spending more time so as to learn to produce quality work with ICT support; this would enable them to extend their creativeness through learning to use ICT more creatively. Similar beliefs were also evident in their responses to the survey about 'self-assessment' of computer applications which clearly portrayed a positive sense in their self-beliefs in their ICT skills for learning. These in turn may enhance classroom practices with the employment of ICT in digital assessment of progress in Engineering Studies. The positive perception of of technology and ICT related knowledge potentially provides a foundation for DFA in this course.

All teachers were positive about ICT supporting pedagogy and keen to develop their ICT skills for learning. Most teachers thought ICT skills were essential to learning in their course work, believing they had adequate ICT pedagogical skills at this time. In the CBAM mapping (refer to Table 5.11) most teachers used ICT for teaching and learning activities with their students. In addition, they considered their students were able to complete the exam in the time-frame allocated because they were confident about using ICT. Their comments from the post-teacher interviews were indicative, being such as, '… students responded well to the use of a computer in designing the project', and their preference for using a computer in the course. They strongly supported the digital assessment method in this study, averring ICT complemented their teaching practices, resulting in more engaging learning activities.

AIT course

The attitudes and perceptions of students and teachers in AIT are discussed in the following passage related to digital assessment, ICT skills and learning.

Digital Assessments

Most students enjoyed using ICT in the assessment tasks of both the exam and portfolio, perceiving that ICT helped them to show quality knowledge when completing the assessment tasks. In their cases the eAssess and eAssessP scale scores had high means of 3.0 and 3.3 respectively, well above the mid-point of 2.5. The cohort of research students believed ICT enabled them greater scope in creating design ideas for application to the assessment tasks in

the exam. Most of them perceived the use of ICT in the creation of their digital portfolios was an appropriate method of show casing their skills. They felt the computer applications helped them in reflecting and showing process throughout the production of the digital portfolio. In addition, they enjoyed the greater flexibility afforded them in completing the digital portfolio with ICT. This was a clear indication of a strong and positive perception of these digital assessments.

Additionally, most students enjoyed, and were generally positive about, the two digital forms of assessment because they believed digital technologies supported their endeavours in many ways engaging them positively in fulfilling the assessment criteria of the course. They perceived assessment in AIT should be practical, this being inferred from students' comments in the open items, the first of which sought responses to, "Best things about doing the AIT exam". Typical examples of such were,'… quicker and easier to create graphics, ease access to information because the materials were all on the computer' (OA), and, '… I was on the computer. I'm better at applied versus theory. Get to show the examiner what we can do on a practical level' (ZA). Similarly for the portfolio they perceived "the best things about doing the AIT exam" were, 'easier to put things together and to edit, i.e. photos and audio recording' (OA); and, '… allowed quicker referencing between parts of the portfolio, and it was faster to record and access data' (VA).

All teachers realised AIT was an applied course, and digital technologies should provide the content of study and pedagogical support; therefore they supported the use of ICT in assessments. Most AIT teachers were confident with implementing digital portfolios and, in most cases, this was typical practice for course work in their classes. Some had employed portfolios as a form of assessment before, but none had used computer-based exams. Despite the teachers' beliefs about ICT applicability, their applications of ICT were mainly concentrated around the mechanical dimension. This was reflected in the CBAM LoU judgements wherein 85% responses were at the mechanical level. For example, ICT was used in teachers' day-to-day lesson preparation and course presentations, but with little consideration of student needs such as feedback for improvement.

The teachers were keen, strong supporters ICT application to assessments in the AIT course, as demonstrated by their committement and involvement in this study. Furthermore they spent a significant amount of time with students in class implementing the digital portfolio as part

of this assessment. This clearly indicated strongly positive attitudes towards the use of digital forms of assessment in the AIT course.

ICT skills and learning

Both students and teachers felt positively about employing ICT learning, perceiving they had the required ICT skills. Most students agreed their ICT skills enhanced their learning, welcoming this learning taking place in an ICT rich environment. They had an affinity with ICT having grown up in the digital era. In their view computers were good for the world, making learning much easier for them. Most teachers claimed competence with using ICT, and deployed a range of ICT in their teaching and learning. They believed ICT skills enhanced students' learning and and capability in producing quality work, inferring in their comments that learning with ICT was relevant to developing ICT skills and consequently those skills could assist students' learning process.

Almost all students in all case studies perceived they were skilled with ICT as they used ICT in their learning both at school and at home. Their teachers confirmed this, believing students were inclined to be more responsive when learning with computers. During the teacher pre- and post interviews, most teachers agreed students enjoyed researching on the Internet. They noted their students were also savvy with another ICT application, social media, communicating competently with their peers readily. This was not a surprising finding because researchers like Prensky (2001) have long acknowledged the 'Y' generation have good ICT skills, even labelling them as 'digital' natives.

Summary of attitudes and perceptions towards ICT use in learning

The transition to digital forms of assessment for Engineering Studies and AIT courses allows the production of an end product while recording, communicating and reflecting on the creative development stages as they actually happen.

In general, both AIT assessments were perceived a little more positively by students and teachers than for the Engineering Studies assessment. Engineering Studies students tended to perceive the need for more time and more flexibility in their endeavours, particularly the order in which subject components were completed. This was not the case for AIT as students and teachers who were in a more familar learning environment because computer lab work was normal. Therefore access to the use of computers was considered a little more convenient,

these students sensing astronger familiarity and affinity with computers than Engineering students, their main advantage being having the materials workshop the main learning environment.

Both students and teachers enjoyed using ICT, considering they had adequate ICT skills. Students were a little less familiar with ICT for assessments because their use had been mainly for research and little related to assessment. This was particularly the case with Engineering Studies students, their AIT counterparts being familiar with digital portfolios which was useful as part of their assessment. All students found the computer-based exam somewhat foreign to them, as pen and paper-based assessment was the only form with which they were familiar. However, most students had sufficient ICT skills to enable the completion of assessment tasks; they definitely preferred these digital forms of assessments over the traditional methods.

Teachers' perceptions of ICT for assessment tended to concentrate at best on test development, for example, using a computer to type exam papers and collate marks/grades. Their primary use of ICT was for instructional purposes being essentially administrative in nature. However, some evidence was apparent of ICT use for assessment with AIT teachers as digital portfolios were applied as part of their regular assessment. Both students and teachers perceived using digital forms of assessment added to the authenticity and enhanced reliability of assessment; they perceived the value and importance of ICT supported assessments.

Both students and teachers agreed ICT was necessary to improve curriculum course delivery. They felt that ICT skills in learning would better align with digital pedagogical practices, the learning environment being extended as a result of the more autonomous forms of learning now available to students through the Internet and ICT.

Feasibility of Digital Forms of Assessment

This study used the four dimensions of a Feasibility framework (Newhouse et al., 2008); Prensky (2001) to investigate the feasibility of each form of assessment. Conclusions from the findings relevant to each dimension will be discussed separately in this section and then compared and contrasted between the Engineering Studies and AIT cases.

Manageability Dimension

For this study manageability pertained to the practicalities of implementing ICT to support digital forms of assessment for both Engineering Studies and AIT in typical classrooms with a normal range of students in WA schools.

Generally speaking, in Engineering Studies cases almost all students and teachers held the belief that the exam was well supported by technology. This led to very positive attitudes and perceptions about the exam and digital forms of assessment in general. They perceived that the exam implemented in this study had been manageable and therefore developed attitudies that future digital assessments would also be manageable. Overall, this positivity would likely assist with the manageability and feasibility of this form of assessment for the Engineering Studies course.

Both AIT students and teachers were positive in their acceptance of both forms of assessment. Students thought the portfolio was a little easier to complete because of the flexibility allowing for some customisation to the context. In addition, the portfolio was completed over a period of 6 weeks in normal class time, not being subjected to exam conditions. Students were familiar with digital portfolios and teachers were experienced with implementing them in the course. Generally, the portfolio was implemented without issues being raised, and for the actual exam only minor technical difficulties were in evidence and could be solved 'on the spot'.

For both Engineering Studies and AIT the teachers in all cases were very positive towards ICT supporting digital assessment. They believed these forms of assessment complemented their own aims, principles and methods of assessment, therefore assisting teachers in planning and organising these types of assessments utilising ICT. Thus the manageability of such assesment tasks would be more feasible in classroom implementation**.**

Technical Dimension

In this study technical pertains to the extent to which existing technologies in schools could be adapted for digital forms of assessment within both Engineering Studies and AIT courses in typical classrooms with normal range of students in WA schools. Likely factors impacting on the technical dimension were: availability of software capable of being used to develop solutions to tasks for both courses; capability of hardware for the tasks to be carried out; and the ease of backup and recovery.

Most schools had sophisticated multimedia software, such as Adobe CS3/4, which included Photoshop, Dreamweaver and Office 2007, on the school computer network system. Therefore students had opportunities to use a range of applications hence believing in their competence to run these applications for the tasks required in the assessments. It was quite apparent students perceived these assessments were technically well supported at their school.

Generally students and teachers thought the forms of assessment in this study were adequately supported by ICT available in their schools. Additionally, almost all students in all cases believed they possessed the required skills to complete the assessments; this aided the overcoming of minor technical issues, such as audio recording and webcam use. Their positivity towards ICT skills would likely enhance the technical feasibility of using digital forms of assessment in schools. An important finding of this study was that, in all cases, the required ICT infrastructure was adequate to ensure the assessment tasks could be completed to an acceptable level in all participating schools.

Functional Dimension

Functionality in this study refers to the validity, reliability and fairness of the two digital forms of summative assessment used in the judgement of practical performance-based outcomes of the Engineering Studies and AIT courses for the normal range of students in WA schools.

Both digital portfolios and performance computer-based exams were implemented in schools in this study. The assessment tasks were structured to permit a good range of levels of achievement to be demonstrated. With both forms of assessment, the exams and/or the portfolio, most students appreciated the opportunity to demonstrate, through ICT, their creativity in performing the tasks. In all cases, students and teachers perceived the assessment tasks to be authentic and meaningfully aligned with their courses. This indicates that using digital forms of assessment in both the Engineering Studies and AIT courses in schools would improve the authenticity of the assessments over that currently implemented

Students were generally happy with the forms of assessment implemented in this study; they were positive about the reliability of the assessment. The essential reason for this attitude was the employment of these types of tasks in their normal class activities; they believed ICT was a reliable way of measuring their performance. Students perceived the assessment to be reliable because the use of digital forms in capturing both the performance the process of their

work was appropriate, providing 'meaning' to practical, performance-based tasks. Teachers perceived the digital forms of assessment utilised to be more meaningful in capturing practical performance-based outcomes, because they believed students were able to demonstrate the development process as well as the final product in the digital forms of assessment used. This attitude is likely to enhance the reliability of digital forms of assessment for Engineering Studies and AIT courses.

Most students were very comfortable working on the digital forms of assessment; they enjoyed using ICT because everything they produced on the computer was already in digital form. Any tasks such as design sketches already developed on paper were easily scanned or digitised. No restrictions were placed on the applications used or the materials required in performing their assessment tasks. Most students' comments from the student forum and open items centred around typical statements as " … the performance exam was fair and easy to follow, this allowed them to show what they could do, and for the portfolio they had the opportunity to explore and research from the ubiquity of internet assess with the support of broadband." Such comments inferred a perception of 'fairness' and 'justice' towards the forms of assessment used in this study.

All students and teachers believed the digital forms used in this study were fair and supported the nature of assessment. Most students perceived the assessments to be engaging, allowing them to demonstrate their abilities in their work. Their positive attitudes and perceptions of fairness in the assessment methods of this study were clear. In this regard, student and teacher support of digital forms would certainly increase the feasibility of the application of these forms for assessment in both the Engineering Studies and AIT courses in WA schools.

Pedagogical Dimension

Pedagogical dimension in this study refers to the extent to which the digital forms of assessment used in the study supported and enhanced teaching and learning. For example, the alignment of digital assessment with classroom curriculum practices in Engineering Studies and AIT courses in WA schools.

The structure of the curriculum for senior schooling in WA has changed dramatically resulting in courses such as AIT and Engineering Studies now having major practical components. Both students taking, and teachers teaching the courses have an expectation that assessment will reflect the nature of this practical pedagogy. Almost all students and teachers

perceived the digital assessment tasks matched the desired, or intended, pedagogy for the course. Discussion with students and teachers, and observation of classes in action, provided the researcher an understanding of typical pedagogical strategies and practices employed being clearly aligned with or matching the intended curriculum in these two courses. However, teachers were using digital technologies mainly for course work preparation and presentation; these applications had little relevance or significance in monitoring authentic curriculum outcomes.

The AIT digital exam was developed directly from the curriculum documents of the AIT Stage 2 course, which includes the following statement: " … application/use of common ICT business software including descriptions, examples and use of personal information managers, presentation software for business, word processing simple spreadsheet basic formulas and charting, publishing and flat databases" (Curriculum Council of Western Australia, 2009, p.3). The digital portfolio task given in this study was a brief for a design to form part of the semester's work, making it a natural part of the pedagogy. It was clear from analysed data, that all students indicated a strong preference for assessment of practical performance using a computer and most indicated that a digital portfolio provided reliable, valid and a fair and just assessment in this study. These findings concured with educational literature such (S-Baden, 2015) rethinking learning in an age of digital fluency and (Redecker, 2013) changing assessment towards a new assessment paradigm using ICT. S-Baden and Reddecker believed there is a need to better understand how ICT for assessment can support modernising schools and education systems. In particular to providing future skills and Key Competences efficiently for all learners. And to understand and how the attitude, perception and skills dimension, as well as creativity can adequately be supported through computer supported assessments. For example emerging computer-enhanced assessment formats and could complement on the tools and environments that are currently use/exists. This would enable schools and teachers to move from knowledge-based to competence-based assessment.

For the Engineering Studies the exam was a series of specified activities, taking students from a design brief to the construction and evaluation of a model over 3 hours. Engineering teachers believed this format of assessment should be a part of the course because it paralled the practical nature of its assessment components. However, there was no evidence this form of assessment was congruent with the students' currently implemented pedagogical strategies. They indicated a preference for a digital, pedagogical environment over a paper-based

learning environment, because they perceived most tasks in the classrooms of today should be performed digitally. This was by supported current literature, such as Masters (2013) reforming education assessment, McGaw (2006) assessment to fit for purposes and Masters (2014) towards a growth mindset in assessment. Lloyd (2008) also found similarly in stating the capability to use ICT in the classroom is an expected part of the teachers' toolkit. Furthermore, observations of students in the course indicated they were familiar with digital technologies being motivated to answer questions wherein they could type, draw and capture images. Teachers in general considered the form of assessment in this study complemented the pedagogy required. Most of them already apply such technologies with their students in class. Students' and teacher's positive attitudes and perceptions towards a digital pedagogical practice is likely to result in a richer learning environment and provide further support to digital forms of assessment within a digital pedagogy.

Limitations of the study

The main limitation to this study was the small sample size of teachers and numbers of classes so limiting the generalisability of the study's conclusions. The selection of twelve teachers and classes were based on the criteria of them being likely to possess the skills to enable implementation of computer-based assessments because of their experience and demonstrated skill in the employing of a range of ICT in their respective pedagogical practices. They had been involved in the development of the digital assessment tasks and were more aware of the capability of their school network infrastructure and its capacity to support the digital assessment tasks to be implemented. This selection process should minimise the difficulties in the application of the assessment tasks in this study.

Although the data sample sizes were small and less representative, there was some diversity among participants and schools. There were male and female teachers, from both private and public schools, who had diverse ICT and Engineering backgrounds, and from Business Information Technology, Digital Media and Manual Arts – Wood, Metal and Technical Drawing curriculum disciplines.

This study was also limited to two forms of digital assessment due to time and implementation constraints. Therefore interpreting the results, drawing conclusions and generalising from these two forms of digital assessment could only point to the creation of more detailed challenges.

While the present study was limited in size and scope, it contributed to a larger study considering a wider range of DFAs with four courses, AIT, Engineering Studies, Italian Studies and PE Studies. The latter included 81 class-based case studies each involving a teacher and a class in one of the four of courses with a total of 1015 students involved. In the final year the main study, a more representative sample of teachers was deliberately selected. This more representative sample would enhance the scalability of the DFA. The present study was limited to a much smaller number of students and teachers in two courses, but contributed to the larger study.

Implications of study for policy and practice

For some time now Australia-wide, school systems have advocated the employment of ICT in schools. Computers were first included in national school-education policy in 1989 as part of the National Goals for Schooling. More recently the Digital Education Revolution policy commited to the provision of ICT across all government schools. State policies have reflected this advocacy (Lloyd, 2008) and the capability to use ICT in the classroom is now an expected part of a teacher's toolkit.

In this study students' and teachers' perceptions of ICT in supporting digital forms of assessment in the Engineering Studies and AIT courses were examined. This study found teachers in both courses embedded ICT into educational practice in schools. Teacher knowledge of pedagogical practices and content dimensions were to take advantage of digital technologies for assessment. These teachers needed to possess basic ICT skills such as word processing, PowerPoint and accessing the Internet, be able to develop sound pedagogical skills to integrate ICT successfully into the curriculum in both these two courses. Thus they would take advantage of ICT to support assessment and challenge students thereby promoting higher order thinking skills (Clarke-Midura & Dede, 2010).

The present study found teachers' perceptions of intended outcomes of the curriculum did align with a digital teaching, assessment and learning environment. They strongly supported the implementation of the digital forms of assessment in both of the courses in this study, believing such DFAs would bring about more obvious congruency between assessment, curriculum and pedagogy. Their positive attitudes and perceptions about the value of ICT for assessment supported its efficacy. In the final analysis, ICT supported digital forms assessments should be policy and best practice in these courses.

Recommendations for further research

Teachers continue to play a pivotal role in creating and implementing educational innovations as they realise curriculum change is inevitable. Consequently, their attitudes and perceptions of innovations and curricula content are crucial to curriculum reform. In addition, teachers' opinions about ICT supporting assessment and employment of ICT in course programs are imperative the implementation of digital forms of assessment is to occur. Therefore it is worthwhile for other researchers to ascertain students' and teachers' attitudes and perceptions of digital forms of assessment beyond the two courses of study in this research, such as PES, Drama/Dance, LoTE and similar courses with practical components in curriculum content. Further research into ICT's possibilities in schools and in society is vital. This research could be replicated using qualitative methods to ensure generalisability of conclusions. More representative samples and replication with larger groups of students, teachers and schools, ultimately for a greater range of courses, both in- and interstate would be invaluable.

Representative sample

The key change would be to include a greater range of students, teachers, classes and schools for various replications, for example, the inclusion of participants less positive or skilled in digital pedagogical practices. This research could be replicated with a larger cross section of schools, public and private, include country and remote schools in WA and other Asiatic cultural settings.

This second phase of the head study investigated students' and teachers' attitudes and perceptions towards digital forms of assessment of the two courses. Currently, pen and paper-based exams are still being used for exam assessments in these courses. In the final phase of the main study a more diverse sample in four courses, AIT, Engineering Studies, Italian Studies and PE Studies was instituted. The conclusions drawn from the current study informed the final phase of the main study. This integration will be discussed in the concluding section of this chapter.

Digital forms of assessment for other courses

Many other courses have practical components that could be challenged for the validity of their assessment of the intended student learning outcomes. A deeper look at the currency of reforms and the potential for greater assessment reliability across other courses of study could produce similar lines of research for the future. Furthermore, the criterion-related validity,

344

construct validity and consequential validity of high stakes assessment must be improved. (McGaw, 2006) supports this contention centred on the validity of assessment on intended learning outcomes on such areas as The Arts, T&E, LoTE, Science and S&E, and to a lesser degree Maths. This is because of a higher content of practical components contained within these courses, with the exception Maths – considered to be more abstact in nature. Students, teachers and the community expect the assessment of student performance to reflect the theorical nature of this learning. In most cases performance on practical tasks clearly cannot be assessed adequately using traditional pen and paper technologies. Therefore, without change to the main high-stakes assessment strategies currently employed there is a reduced likelihood of productive use occurring with digital forms of assessments. Consideration of the need to improve validity of the assessment of student practical performance, a strong rationale is possible for recommending further research into Digital Forms of Assessment.

In typical WA senior secondary schools it would be possible to implement a range of digital forms of assessment even in those courses do not typically operate in an environment with ICT available. Recent advances in psychometric methods and improvement in digital technologies have provided tools to assess a variety of performance cost-effectively (McGaw, 2006). Many of the schools currently have multi-function rooms capable of accommodating normal class sizes which have the capacity to function adequately as an ICT lab. In addition, most of these schools employ technicians an IT support person on site. The current ICT infrastructure in the schools involved in this study adequately supported the implementation of the two forms of DFA for both the courses. However, any approach or strategy will not be perfect, thereby requiring compromises.

A strong rationale for courses can be made having practical components in senior secondary schools in WA to be assessed using digital forms. Additionally, these digital forms of assessment are freely available and be implemented in a typical school with normal students. Importantly, these various digital forms are affordable for schools; thus a reasonable expectation of students and the community is that the assessment of student work should reflect the nature of their learning. These digital forms of assessment have been shown in this study to be potential replacement for existing paper-based assessments.

Best practices in digital forms of assessment

A strong rationale is apparent for future research to explore alternative methods of assessment and changes to paper-based assessment strategies currently employed. Numerous examples of

digital technologies in assessment are extant; however, their deployment in high-stakes school-level performance assessment is relatively rare. Several means of assessing student performance using DFAs exist. For example, a project portfolio or computer-based production exam assessment could be utilised as in this study. Other possible DFAs could include exploring the use of reflective portfolios, performance task exams, simulations, oral presentations, interviews and audio-visual recordings. Digital forms of assessment could also be extended to incorporate web-based/online systems.

Conclusion

In today's ICT world, the Internet and on demand, real-time interactive information highway, it is not necessary for students and teachers to carry enormous amounts of information around in their heads, but require quick and reliable access to information from multiple sources. Digital forms of assessment may be utilised to represent knowledge and record evidence observing performance. Lin and Dwyer (2006) suggest the demonstration of higher-order skills such as, decision making, reflection, reasoning and problem solving is better facilitated through ICT. Therefore assessment of higher order thinking skills of analysis, synthesis and evaluation is inevitable. In this study, two forms digital of assessment (DFAs) have been employed; a digital portfolio and a computer performance product-based exam. Both digital forms were considered appropriate for the employment of digital technologies to capture, collate, mark and analyse student practical performances in the Engineering Studies and AIT courses in compliance with the WA SCSA' requirements. Both of these means of assessment resulted in greater authenticity than purely paper-based exams. These forms illustrated best practice in aligning assessment and pedagogical content. The digital forms of assessment employed in this study demonstrated the appropriateness and relevance of this judgement of practical performance-based outcomes. The process and practices adopted in both forms of assessment were parallel with, and supported the nature of summative assessment principles; it was favourably endorsed by students and teachers involved in the study.

The computer-based performance exams were successfully implemented in both of the courses with the ICT infrastructure in all schools involved found to be adequate thereby ensuring the assessment task could be completed to an acceptable level. Implementation of the AIT portfolio allowed students to demonstrate their capability with the AIT application having some scope for tailoring to meet the cicumstances of students in individual schools.

This resulted in some discrepancies between teachers' interpretations in the facilitation of the portfolio. Thus future improvement in AIT implementation must be supported by an online portfolio management system, with a well-structured system for monitoring, including a series of spot checks; students and teachers could then enhance its introductory practices so they accord with the set conditions and procedures.

It was possible to implement ICT supported assessment tasks for the two courses because students and teachers in the schools already used digital technology, thus they were generally familiar with the capabilities of ICT used daily at school and at home (Gardner & Eng, 2005). Their understanding and positive attitudes towards the process of human-computer interaction also led to beliefs in the value of ICT for assessment. All these intrinsic factors are fundamental to ICT integration and improved feasibility in of ICT to support assessment regardless of its form. Furthermore Hall (2010) argued supportively that, although pedagogical content knowledge is an important enabler, epistemology and conceptions for teaching/assessment are intrinsic factors, directly or indirectly, related to the practice of technology integration. Students and teachers believed ICT use in the exams was a key enabler for the successful implementation of DFA in both courses. This study assisted in informing stakeholders about educational digital technologies and the appropriateness of pedagogical application in courses like Engineering Studies and AIT in senior secondary schools in WA.

This study supports the argument for the validity of digital assessment over pen and paper exams, because students no longer write expansively, digital technologies having already transformed methods of communication, particularly of teaching. Researchers like Shepherd (2010) echo sentiments such as:- *the way students are tested isn't overtaken by the modern world and doesn't become a relic of the early 20th century*. Likewise Hobson (2009):- *exams must reflect daily life in the classroom and daily life in the classroom has to reflect life in society*.

This study has argued that the key to the feasibility of implementing digital forms of assessment rests in better assessment information/understanding of the potential of ICT supported assessments; students' and teachers' attitudes and perceptions of the value of ICT driving learning and teaching are just as important. Their attitudes concerning the application of ICT are crucial to the repurposing of assessment and pedagogy as being broadly reflective of 21st century life.

Assessment is an integral and essential component of effective learning, teaching and educational decision-making process. Improvements in the quality of assessment methods and forms of assessment have the potential to enhance the effectiveness of decisions made by teachers, educational leaders, parents and learners themselves, resulting in better learning and better educational outcomes. Students' and teachers' attitudes and perceptions are crucial to the success of these improvements in assessments, particularly moving towards digital forms of assessment in courses which have a significant performance-based component in their curriculum.

Teachers sense a paradigm shift accompanying increasing technology applications, but which is not evident in the broader educational context. Thus, a tension has developed for teachers, which must be resolved. Coincidentally, unprecedented external pressures are obvious for assessment reform. These pressures include: the need for better information to guide and evaluate decision making; advances being made in understandings of human learning; calls for greater emphasis on the development of a broader range of life skills and attributes; and changes in the 'where and how learning' takes place, particularly those result from technological advances. Advances in technology have raised the possibility and challenge of fundamentally transforming assessment processes and information in future.

Our society increasingly expects students to demonstrate practical performance not just be receptacles for theoretical knowledge or facts. Thus teaching, learning and assessment simply cannot be meaningfully addressed employing traditional, pen and paper-based forms for measuring performance-based outcomes. These attitudes and perceptions are important factors in the feasibility of using digitally-based representations to measure student work output for assessment purposess: these were the opinions reflected by both the Engineering Studies and AIT students and teachers, and supported by those such as McGaw (2006).

From the positive attitudes and perceptions students and teachers have evidenced in this study, it could be argued there to be a high expectation from them and the community that assessment of student performance should reflect the practical nature of learning in both these courses. In addition, the relative cost of digital technologies and devices are cheaper and easier to use and locate than at any previous time. Therefore the right moment has emerged for transitioning from traditional methods of assessment to digital forms as AIT and Engineering Studies students and teachers in this study have demonstrated.

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Appendices

Appendix A - CBAM Innovation Configuration

1. Access to ICT to support assessment. (1) Teacher has access to ICT for assessment at all times.	(2) Teacher has some access to ICT for assessments at home or school.	(3) Teacher may have access to ICT for assessments at home.	(4) Teacher does not have access to ICT to support assessment.
2. Digital Forms of Assessment (1) Teacher uses a variety of digital forms of assessments with their courses.	(2) Teacher may use one form of digital assessment.	(3) Teacher uses no alternative ICT assessments with their courses.	(4) Teacher does not use digital forms of assessment, but may use ICT to collate marks and recording.
3. ICT and Pedagogy (1) Teacher uses ICT for most learning activities.	(2) Teacher uses ICT for some learning activities.	(3) Teacher uses ICT for teaching, presentation and for preparation of resources.	(4) Teacher does not use ICT for teaching and learning.

Appendix B - CBAM Stages of Concern

Stage	Description
0 Awareness	Little concern about or involvement with using ICT for assessment.
1 Informational	A general awareness of using ICT for assessment and interest in learning more detail about ICT for assessment. The person seems to be unworried about herself/himself in relation to the use of ICT for assessment. She/he is interested in substantive aspects of Digital Assessment in a selfless manner such as general characteristics, effects and requirements for use.
2 Personal	Individual is uncertain about the demands of the use of ICT for assessment, her/his inadequacy to meet those demands, and her/his role with ICT assessment. This includes analysis of her/his role in relation to the reward structure of the organisation, decision-making, and consideration of potential conflicts with existing structures or personal commitment. Financial or status implications of the program for self and colleagues may also be reflected.
3 Management	Attention is focused on the processes and tasks of using ICT for assessment and the best use of ICT and resources. This is mainly related to efficiency, organising, managing, scheduling and time.
4 Consequence	Attention forces on the impact of ICT assessment on her/his immediate sphere of influence. The focus is on relevance of the use of ICT for assessment with the students, evaluation of student outcomes, including performance and competencies, and changes needed to increase student outcomes.
5 Collaboration	The focus is on coordination and cooperation with others regarding use of the ICT for assessment.
6 Refocussing	The focus is on exploration of more universal benefits from the use of ICT assessment, including the possibility of major changes or replacement with a more powerful alternative. Individual has definite ideas about alternatives to the proposed or existing form of the use of ICT in schools.

Appendix C - CBAM Levels of Use

0 Non-Use	State in which the user has little or no knowledge of the use of ICT, no involvement with the use of ICT, and is doing nothing toward becoming involved using ICT assessment.
1 Orientation	State in which the user has acquired or is acquiring information about the using ICT for assessment and /or has explored or is exploring its values orientation and its demands upon user and user system.
2 Preparation	State in which the user is preparing for the first use of ICT for assessment.
3 Mechanical Use	State in which the user focuses most effort on the short-term, day-to-day use of ICT for assessment with little time for reflection. Changes in use are made more to meet user needs than client needs. The user is primarily engaged in a stepwise attempt to master the tasks required to use ICT for assessment, often resulting in disjointed and superficial use.
4 Routine	Use of ICT for assessment is stabilised. Few if any changes are being made in ongoing use. Little preparation or thought is being given to improving ICT use or its consequences.
5 Refinement	State in which the user varies the use of ICT to increase the impact on clients within immediate sphere of influence. Variations are based on knowledge of both short-term and long-term consequences for clients.
6 Integration	State in which the user is combining own efforts to use ICT assessment with related activities of colleagues to achieve a collective impact on clients within their common sphere of influence.
7 Renewal	State in which the user re-evaluates the quality of use of the ICT for assessment, seeks major modifications of or alternative to present ICT assessment to achieve increased impact on clients, examines new developments in the field, and explores new goals for self and the system.

Appendix D - Engineering Student Forum Transcript

Quest	GE	HE	LE	RE	WE
Q1 Task	Reflected the curriculum This form of assessment was better than pen and paper	Allowed creative thinking/skills Relevant to Engineering course work	It was easy and enjoyable	It's good, interesting and real	It was easy –activities were time and organised in boxes (1-19)
Q2 Quality	Yes	Better quality in outlining the task	Yea better than pen and paper	Related to industry has a real feeling about the task quality	Depends on whether you were good or not using computers to do the exam.
Q3 Help	Can meaningfully demonstrate process	Computers helped them in both assessments	Computers helped and its faster	In some task activities because the lack of familiarity with some software	Better than pen and paper. All work were stored into a folder this is good.
Q4 Differences	A lot less theory work	Very different – computers were never part of practical exams	Very – we always do exams with pen and paper Different skills needed		It was very different. It is more relevant than pen and paper.
Q5 Changes	Text displayed on the EeePC screen	Improve Internet access time	More time needed Bigger screen		A bigger keyboard to use. More section breakdown into sub-sections.
Q6 Tech Issues	Screen/PC froze	Recording audio files	Clarity of webcam		Webcam not reliable enough.
Q7 Other problems	Time allocated to Activity box 16 – too	Wait for all students to complete each task in order to proceed to the next	No		No

	short	activity		
Q8 Other suggestions	Picture quality, larger screen	Use a tablet for drawing	Keep future exams in this format i.e. computer-based	Have a practice run before the real exam.

Appendix E - AIT Student Forum Transcript

Quest	NA	OA	VA	XA	ZA
Q1 Task	Too long and uninteresting	Portfolio was better than the exam	Practical exam/portfolio makes sense in a practical course	Exam was easier than the Portfolio	Portfolio was better than the exam
Q2 Quality	A bit of a rush but acceptable	Able to show quality work	Can produce better work with computers	Happy with the work in the exam	Could produce quality work
Q3 Help	Most said yes, two said nos	Computers helped them in both assessments	Yes and we are familiar with computers	Most said no and one yes	Yes it was interactive – couldn't do this on paper
Q4 Differences	A lot better than paper	Familiar with portfolio, but not computer-based exam	Big improvement for practical work	Different to pen and paper	Very different to our previous exam – theory-based
Q5 Changes	More time needed	More for time in the exam	Clearer instructions	More time needed	Re-phrase the term artefact
Q6 Tech Issues	Slow computers, audio did not work	Uploading into MAPs	Computer crashed resulted in lost work	Slow computers	Audio and firewall with computers
Q7 Other problems	Exam instructions not clear	Wording in the exam-not explicit	No	Exam instructions	No other issues
Q8 Other suggestions	Provide newer computers	Practice run before the actual exam	Compensation for lost work	Improvement on video and graphics display	No

Appendix F – Engineering studies student survey questionnaire

STUDENT SURVEY – Digital Assessment Project   ID [   ]

ENGINEERING STUDIES

Please read the following Disclosure Statement carefully as it explains what this research is about.

Disclosure Statement

This questionnaire forms part of the evaluation of the use of computers at the school to help the assessment of learning. What you as a student think and the activities you are involved in at school are very important to this evaluation and therefore we are surveying students from your class to collect this information.

Your responses will be strictly confidential. The information will be collated with no reference to individuals and no identifying information for reports to the school and teachers at the school. Such reports will only include general and summary information and will in no manner identify individual or groups of students or teachers.

Instructions to Students

Please do not write your name on the survey sheet. Put your ID code on the sheet, only this will be recorded and known only to the research team. The ID code will maintain the confidentiality of your responses and also provide a way of re-identifying your data if you choose to withdraw from the project.

To ensure maximum confidentiality all the questionnaires from your class will be placed in a sealed envelope to be returned to Edith Cowan University. Therefore no one at your school will see your questionnaire.

It should take you about 15 to 20 minutes to answer the questions but take as long as you need.

Please use PENCIL so that you can erase and change responses if necessary.

Some items require you to CIRCLE or TICK an alternative while others provide the opportunity for you to write brief responses (note form is OK).

Example
(a) I like going to school.   (Often) Some   Rarely   Never

CAREFULLY ANSWER THE QUESTIONS ON THE FOLLOWING PAGES

STUDENT SURVEY – Digital Assessment Project

Please circle ONE response for each row.

Gender (circle): Male / Female

Doing design projects on computers

E1.	(a)	How often have you done a design project on a computer before?	Lots	Some	Little	None
	(b)	How much more time would you need to get used to it?	Lots	Some	Little	None

Doing the Engineering design project

E2.	(a)	It was easy to use the computer for doing the project.	Strongly agree	Agree	Disagree	Strongly disagree
	(b)	It was easy to use the computer to develop my design ideas.	Strongly agree	Agree	Disagree	Strongly disagree
	(c)	The computer was a quick way for recording my design ideas.	Strongly agree	Agree	Disagree	Strongly disagree
	(d)	The computer was good to record my design and modelling.	Strongly agree	Agree	Disagree	Strongly disagree
	(e)	The computer was good for evaluating my and others design ideas.	Strongly agree	Agree	Disagree	Strongly disagree
	(f)	The computer was good for compiling my portfolio.	Strongly agree	Agree	Disagree	Strongly disagree
	(g)	It was easy to follow the steps of the design on the computer.	Strongly agree	Agree	Disagree	Strongly disagree
	(h)	The steps of the project helped me to develop my design ideas.	Strongly agree	Agree	Disagree	Strongly disagree
	(i)	Overall, the computer is a good tool for designing and modelling.	Strongly agree	Agree	Disagree	Strongly disagree
	(j)	Overall, I was able to show what I can do in the project.	Strongly agree	Agree	Disagree	Strongly disagree
	(k)	Overall, it was better doing the design project using a computer than on paper.	Strongly agree	Agree	Disagree	Strongly disagree

E3.   The two best things about doing the Engineering exam using computers:

👍

👍

E4.   The two worst things about doing the Engineering exam using computers:

👎

👎

Experience and Knowledge with Computer Technology

5.   What do you use at home? (Circle ANY of the following that apply to you)

384

Computer   Digital Camera   Video Camera   MP3 Player (e.g. iPod)

Laptop Game Console Mobile Phone   Webcam

6.   Do you have Internet access at home? (Circle ONE)

NO Internet   Dial-up Internet Broadband Internet

Circle the response that best describes how often you use a computer at home.

        Most Days   More than once a week   Most Weeks   Rarely

8.   Estimate the amount of time in MINUTES you spent using computers at school on each day LAST WEEK.

Monday	Tuesday	Wednesday	Thursday	Friday

9.   When you type do you try to touch type (use all of your fingers)?   YES or NO

10.   Do you, or would you, use a computer to do the following tasks? (Circle ONE for each)

(a)   Keep a list of addresses of friends.   I do   I would No

(b)   Draw a diagram or picture.   I do   I would No

(c)   Type an assignment for school.   I do   I would No

(d)   Do a line graph or pie-diagram as part of an assignment. I do   I would   No

(e)   Send a letter to every sports club member or group of friends. I do   I would No

(f)   Communicate using sites like MySpace, Facebook, Youtube. I do   I would No

11.   Circle YES or SOMETIMES or NO to show whether you agree with each of the following statements.

(a)   Using computers makes the work at school more difficult. . . . .   YES or SOMETIMES or NO

(b)   I enjoy using computers at school. . . . .   YES or SOMETIMES or NO

(c)   I like to use a computer at home to do school work. . . . .   YES or SOMETIMES or NO

(d)   I like to find things out for myself instead of being told by the teacher. …   YES or SOMETIMES or NO

(e)   Computers are good for the world. . . . .   YES or SOMETIMES or NO

12.   Circle either "YES", "Not Sure" or "NO".

(a)   I feel confident working with computers . . . .   YES   Not Sure   NO

(b)   I'm good at using computers. . . . .   YES   Not Sure   NO

(c)   I feel OK about trying a new problem on the computer. . . . .   YES   Not Sure   NO

(d)   I usually do well with computers. . . . .   YES   Not Sure   NO

(e)   I could learn to program a computer. . . . .   YES   Not Sure   NO

(f)   Using a computer is very hard for me. . . . .   YES   Not Sure   NO

13.   Rate yourself on your skill level in using each of these types of computer software and equipment. For each row TICK the CELL that best describes your skills.

a	Word processor	I can't do much	I can print a document, change fonts, spell check, and insert a footer and page numbers.	I can insert images, create tables, change Page Setup, and change margins.	I can use columns and sections, set up styles, and use mail merge.
b	Spread sheets	I can't do much	I can enter data, use Sort, create charts [graphs] and modify them.	I can insert some calculations, format cells, insert and delete rows and columns.	I can use complex formulae; use absolute and relative cell references.

c	Databases	I can't do much	I can create data files, enter data, and use simple queries to retrieve data.	I can create simple tables, use wizards to create reports and forms.	I can create a relational database.
d	Slideshow software (e.g. PowerPoint)	I can't do much	I can create a slideshow; insert images, change font and layout.	I can navigate during a presentation, add animation and transitions, insert hyperlinks.	I can create a master slide, include sound, print handouts, and add navigation buttons.
e	Email	I can't do much	I can send and access emails, and add to and access Address book entries.	I can store messages in folders, locate Sent and Deleted messages, manage the Address book.	I can add a Signature, and add attachments.
f	Computer File Management	I can't do much	I can save files in a folder, create and name folders, navigate between folders, copy, delete and rename files.	I can recognise different file types, navigate between Drives and Directories, access a network, use Help files.	I can zip and unzip files, install software.
g	The Internet	I can't do much	I can navigate to known web sites, create Favourites, do basic searches.	I can save images and text, use Advanced search tools, organise Favourites.	I can conduct complex searches, download and install plugins, use different browsers, alter browser preferences.
h	Web page authoring	I can't do much	I can create pages and links, insert and format text, insert images.	I can use tables, create external links and email links.	I can create a website with pages and folders, insert sound, upload files to the web.
I	Digital photography	I can't do much	I can take photos or video, transfer to a computer.	I can review images/video on camera, adjust camera settings such as flash and close-up.	I can adjust camera menu options such as resolution.
j	Image editing	I can't do much	I can do simple editing such as crop, delete and draw.	I can change image size, format and resolution.	I can undertake complex image manipulation using filters and other special effects.
k	Video editing	I can't do much	I can do simple editing such as crop, delete and insert.	I can use basic software to introduce transitions, import and edit sound track, add titles and subtitles.	I can use advanced software to apply complex editing and special effects.

THANK YOU FOR YOUR HELP.

Appendix G - Teacher Pre Interview Questions

Teacher Interview – Part A (Pre)

Digital Forms of Assessment   Name …………………………….

1.   (a) Do the students in your class use computers for assessment purposes?   Yes/No

        (b) Do you use computers with your class for other purposes? What for?

(c) Do you think computers can be used to promote more authentic assessment in your subject area?

        YES   NO   NOT SURE

        Why? Please explain briefly.

        [if YES to part (a) go to Q5]

2.   Have you made a decision to use computers for assessment in the future? YES/NO

If so when? [If they have stopped using computers go to Q11]

3.   Are you currently looking for any information about using computers for assessment? YES/NO

What kinds?

For what purpose?

4.   What plans have you made about using computers for assessment?

GO TO Q11

5.   Describe how you have used computers in your classroom.

        (a)   Specifically what do your students do with the computers?

        (b)   Were there any sessions that you specifically designed with the use of the computers in mind? What did you do?   Yes/No

        (c)   What stops you using computers more?

        (d)   What proportion of time would you like to see your students using computers in the classroom?

6.   What do you see as the strengths and weaknesses of using computers for assessment purposes in your situation? Have you made any attempt to do anything about the weaknesses?

7.   Are you currently looking for any information about using computers for assessment?

What kinds?

For what purpose?

8.   What do you see as being the effects of using computers for assessment on your programme?

9.   What plans do you have in relation to using the computers in assessment?

        If NO go to Q11.

10.   How do you work together with other staff in using computers for assessment?

11.   How would you describe your current attitude towards using computers for assessment?

Appendix H - Descriptive Statistics - Engineering Case Studies

Student results

	Engineering Student Population		Class GE			Class HE			Class LE			Class RE			Class WE		
	Pop Mean	P SD	Mean	SD	Effect Size	Mean	SD	Effect Size	Mean	SD	Effect Size	Mean	SD	Effect Size	Mean	SD	Effect Size
q1a	2.44	1.02	2.60	0.91	0.16	2.33	1.20	-0.11	2.08	0.67	-0.35	3.14	0.86	0.68	2.18	1.01	-0.25
q1b	2.70	0.82	2.73	0.88	0.04	2.62	0.74	-0.10	2.83	0.72	0.16	2.64	0.93	-0.07	2.73	0.88	0.04
q2a	1.85	0.63	1.53	0.52	-0.51	2.14	0.57	0.46	1.75	0.62	-0.16	2.00	0.68	0.24	1.73	0.63	-0.19
q2b	2.01	0.68	1.60	0.51	-0.60	2.14	0.36	0.19	2.00	0.43	-0.01	2.14	0.77	0.19	2.09	0.97	0.12
q2c	1.81	0.91	1.00	0.00	-1.00	2.29	0.64	0.59	1.67	0.78	-0.17	2.00	0.78	0.23	1.86	0.89	0.06
q2d	1.87	0.80	1.27	0.46	-0.85	2.29	0.56	0.59	1.58	0.67	-0.41	2.14	0.66	0.38	1.86	0.71	-0.01
q2e	1.90	0.73	1.67	0.72	-0.32	2.24	0.83	0.47	1.75	0.62	-0.21	2.07	0.62	0.23	1.71	0.64	-0.26
q2f	1.64	0.70	1.20	0.41	-0.64	1.90	0.64	0.38	1.50	0.67	-0.20	2.07	0.83	0.62	1.50	0.60	-0.20
q2g	1.65	1.0	1.60	0.63	-0.07	1.76	0.70	0.16	1.58	0.67	-0.10	1.86	0.36	0.31	1.50	0.80	-0.22
q2h	1.95	1.0	1.73	0.59	-0.31	1.90	0.63	-0.07	2.08	0.67	0.18	2.00	0.58	0.07	2.05	0.95	0.14
q2i	1.81	1.0	1.33	0.49	-0.64	1.86	0.66	0.07	1.92	0.67	0.15	2.07	0.92	0.35	1.86	0.83	0.07
q2j	1.88	0.74	1.33	0.49	-0.74	2.35	0.67	0.63	1.75	0.62	-0.17	1.85	0.69	-0.04	1.91	0.81	0.04
q2k	1.83	1.0	1.20	0.41	-0.70	2.05	0.89	0.25	1.83	0.94	0.00	2.07	0.92	0.27	1.91	0.97	0.09
q5_com	0.80	0.41	0.73	0.46	-0.12	.71	0.46	-0.17	0.83	0.39	0.12	0.79	0.43	0.02	0.86	0.36	0.19
q5_dig	0.74	0.44	0.67	0.49	-0.16	.81	0.40	0.16	0.83	0.39	0.20	0.64	0.50	-0.23	0.73	0.46	-0.02

q5_vid	0.50	0.50	0.40	0.51	-0.20	.57	0.51	0.14	0.33	0.49	-0.34	0.43	0.51	-0.14	0.64	0.49	0.28
q5_mp3	1.0	0.26	1.0	0.41	-0.50	1.00	0.00	0.27	1.00	0.00	0.27	0.93	0.27	0.00	0.91	0.29	-0.08
q5_lap	0.82	0.39	1.0	0.41	-0.05	.95	0.22	0.34	0.67	0.49	-0.39	0.86	0.36	0.10	0.77	0.43	-0.13
q5_gam	0.85	0.37	1.70	0.35	0.05	.90	0.30	0.14	1.00	0.00	0.41	0.79	0.43	-0.16	0.73	0.46	-0.33
q5_mob	0.90	0.33	1.80	0.41	-0.25	1.00	0.00	0.37	0.67	0.49	-0.64	0.93	0.27	0.15	0.91	0.29	0.09
q5_wbc	0.50	0.50	.60	0.51	0.22	.57	0.51	0.16	0.50	0.52	0.02	0.43	0.51	-0.12	0.36	0.49	-0.26
q6	3.0	0.28	2.93	0.26	-0.04	2.95	0.22	0.04	3.00	0.00	0.21	2.93	0.27	-0.04	2.91	0.43	-0.11
q7	1.25	0.56	1.27	0.46	0.04	1.19	0.68	-0.11	1.25	0.45	0.00	1.00	0.00	-0.45	1.45	0.67	0.36
q8mon	53	61	87.00	72.65	0.55	48.29	41.57	-0.09	35.17	86.24	-0.30	77.14	48.74	0.39	30.41	44.91	-0.38
q8tue	48	46	72.67	58.98	0.54	46.71	36.59	-0.02	45.00	45.23	-0.06	58.21	51.58	0.23	26.82	33.15	-0.46
q8wed	63	65	84.00	64.34	0.32	50.95	44.46	-0.19	78.25	100.5	0.23	74.64	56.31	0.18	45.23	60.37	-0.28
q8thu	62	56	96.33	60.37	0.59	62.38	49.01	0.00	70.00	65.64	0.13	63.93	49.31	0.03	34.09	55.00	-0.49
q8fri	62	64	102.67	74.97	0.61	59.76	61.49	-0.05	46.25	72.15	-0.26	72.86	54.02	0.15	42.91	51.74	-0.32
q9	1.36	0.48	1.60	0.51	0.50	1.30	0.47	-0.12	1.25	0.45	-0.23	1.27	0.47	-0.19	1.35	0.49	-0.02
q10a	2.25	0.82	2.07	0.80	-0.22	2.38	0.74	0.16	2.45	0.82	0.24	1.93	1.00	-0.39	2.36	0.79	0.13
q10b	2.17	0.90	2.20	0.86	0.03	2.33	0.80	0.18	2.17	0.94	0.00	1.71	0.91	-0.52	2.27	0.94	0.11
q10c	1.07	0.30	1.00	0.00	-0.23	1.05	0.22	-0.07	1.08	0.29	0.03	1.21	0.58	0.46	1.05	0.21	-0.07
q10d	1.49	0.72	1.53	0.83	0.06	1.71	0.85	0.31	1.75	0.62	0.36	1.50	0.76	0.01	1.09	0.29	-0.56
q10e	1.58	0.76	1.13	0.35	-0.59	1.90	0.77	0.42	1.58	0.79	0.00	1.57	0.76	-0.01	1.59	0.85	0.01
q10f	1.18	0.47	1.13	0.52	-0.11	1.24	0.44	0.13	1.08	0.29	-0.21	1.07	0.27	-0.23	1.27	0.63	0.19
q11a	2.61	0.64	2.79	0.43	0.28	2.52	0.51	-0.14	2.75	0.62	0.22	2.64	0.75	0.05	2.50	0.80	-0.17
q11b	1.35	0.63	1.20	0.41	-0.24	1.19	0.40	-0.25	1.25	0.45	-0.16	1.43	0.65	0.13	1.59	0.91	0.38

q11c	1.26	0.50	1.13	0.35	-0.28	1.19	0.40	-0.15	1.33	0.49	0.15	1.43	0.51	0.36	1.27	0.55	0.02
q11d	1.61	0.58	1.50	0.52	-0.19	1.81	0.60	0.34	1.42	0.52	-0.33	1.57	0.65	-0.07	1.64	0.58	0.05
q11e	1.25	0.46	1.20	0.41	-0.11	1.33	0.48	0.17	1.33	0.65	0.17	1.21	0.43	-0.09	1.18	0.40	-0.15
q12a	1.11	0.41	1.13	0.52	0.05	1.10	0.30	-0.02	1.08	0.29	-0.07	1.14	0.54	0.07	1.09	0.43	-0.05
q12b	1.17	0.41	1.13	0.52	-0.10	1.19	0.40	0.05	1.08	0.29	-0.22	1.21	0.43	0.10	1.18	0.40	0.02
q12c	1.20	0.46	1.13	0.35	-0.15	1.19	0.40	-0.02	1.17	0.39	-0.07	1.29	0.61	0.20	1.23	0.53	0.07
q12d	1.12	0.36	1.07	0.26	-0.14	1.10	0.30	-0.06	1.00	0.00	-0.33	1.29	0.61	0.47	1.14	0.35	0.06
q12e	1.62	0.73	1.47	0.64	-0.21	1.86	0.79	0.33	1.42	0.67	-0.28	1.43	0.65	-0.26	1.73	0.77	0.15
q12f	2.79	0.58	2.73	0.70	-0.10	2.95	0.22	0.27	3.00	0.00	0.36	2.57	0.76	-0.38	2.68	0.72	-0.19
q13_wp	3.60	0.52	3.60	0.51	0.00	3.65	0.49	0.10	3.58	0.52	-0.04	3.43	0.65	-0.33	3.68	0.48	0.15
q13_ss	3.10	0.71	2.87	0.83	-0.32	3.10	0.79	0.00	3.33	0.49	0.32	2.93	0.83	-0.24	3.23	0.53	0.18
q13_db	2.47	1.04	2.47	1.13	0.00	2.00	1.03	-0.45	3.17	0.84	0.67	2.79	0.80	0.31	2.32	1.04	-0.14
q13_sl	3.60	0.58	3.60	0.63	0.00	3.55	0.61	-0.09	3.75	0.45	0.26	3.29	0.73	-0.53	3.77	0.43	0.29
q13_em	3.66	0.55	3.60	0.51	-0.11	3.75	0.44	0.16	3.75	0.62	0.16	3.43	0.76	-0.42	3.73	0.46	0.13
q13_fm	3.55	0.68	3.27	0.80	-0.41	3.65	0.75	0.15	3.75	0.62	0.29	3.64	0.50	0.13	3.50	0.67	-0.07
q13_in	3.72	0.55	3.67	0.49	-0.09	3.80	0.52	0.15	3.83	0.58	0.20	3.50	0.76	-0.40	3.77	0.43	0.09
q13_wa	2.64	1.10	2.53	1.06	-0.10	2.85	1.23	0.19	2.25	1.14	-0.35	2.93	0.73	0.26	2.55	1.18	-0.08
q13_dp	3.52	0.74	3.33	0.82	-0.26	3.65	0.67	0.18	3.50	1.00	-0.03	3.29	0.73	-0.31	3.68	0.57	0.22
q13_ie	3.34	0.80	3.20	0.86	-0.17	3.50	0.69	0.20	3.33	0.78	-0.01	3.36	0.84	0.02	3.27	0.88	-0.09
q13_dv	2.81	0.97	2.73	1.03	-0.08	2.85	1.14	0.04	2.92	0.90	0.11	2.57	0.76	-0.25	2.91	0.97	0.10

Appendix I - Engineering Student Forum - Questions

Student Forum   School ……………………………….

Digital Forms of Assessment   Date ……………………………….

Looking back on the Engineering Studies practical exam that you did a few weeks ago, we would like your thoughts to be part of our research report. Your comments will be attributed anonymously as a group (eg) as 'student group 6'.

What did you think of the task(s) you were asked to do?

•

•

What were the reactions of other students' to the task(s)?

•

•

Where you able to do your best quality of work? Did the computers help?

•

•

How much different was this to how it used to be done?

What, if anything, would you like changed in future?

•

•

Were there any technical problems with doing the activities?

•

•

Were there any other problems with the activities?

•

•

Any other thoughts … or suggestions for developing the use of digital forms of assessment?

•

•

We are really very grateful for your help.

•

•

Appendix J - Teacher Post Interview Questions

Teacher Interview – Part B (Post)

Digital Forms of Assessment   Name ……………………………..

Looking back on the Engineering design task that you ran with your students this year, we would like your thoughts to be part of our research report. Your comments will be attributed anonymously (eg as 'teacher 6', and we would like to use any quotes that help us to capture the event, the atmosphere of the activities, and your thoughts about it. Add or delete dot-points as required.

What did you think of the assessment task overall?

•

•

•

What did you think of the structure of the activities? (timing / sub-tasks / instructions)

•

•

•

What were the students' reactions to the activities?

•

•

•

What do you think of it's potential? (for other subjects)

•

•

•

What did you think of the quality of work produced by your students for this task?

•

•

•

Were you surprised by the performance/attitude of any students? (pleased / disappointed)

•

•

•

What was the general feedback from students?   (would they like more of it?)

•

•

•

Were there any technical problems with implementing the activity?

•

•

•

Were there any other problems with implementing the activity?

-

-

-

Any other thoughts … or suggestions for developing the use of digital forms of assessment?

-

-

-

We are really very grateful for your help in completing this form

Appendix K - Descriptive Statistics - AIT Case Studies

Student Questionnaire	AIT Student Population		Class NA			Class OA			Class VA			Class XA			Class ZA		
	Pop Mean	Pop SD	Mean	SD	Effect Size	Mean	SD	Effect Size	Mean	SD	Effect Size	Mean	SD	Effect Size	Mean	SD	Effect Size
E1a	3.22	0.77	3.40	0.82	0.23	3.00	0.46	-0.29	3.53	0.77	0.40	3.05	0.95	-0.22	3.19	0.65	-0.04
E1b	2.58	0.83	2.67	0.82	0.11	2.35	0.99	-0.28	2.74	0.81	0.19	2.68	0.89	0.12	2.44	0.51	-0.17
E2a	2.01	0.63	2.23	0.74	0.35	2.29	0.46	0.44	1.95	0.69	-0.10	1.82	0.66	-0.30	1.87	0.50	-0.22
E2b	2.16	0.70	2.20	0.77	0.06	2.29	0.46	0.19	2.35	0.81	0.27	1.95	0.72	-0.30	2.00	0.63	-0.23
E2c	1.94	0.68	2.20	0.77	0.38	2.10	0.62	0.24	1.85	0.67	-0.13	1.77	0.75	-0.25	1.81	0.54	-0.19
E2d	1.70	0.69	1.79	0.70	0.13	2.05	0.67	0.51	1.65	0.74	-0.07	1.50	0.60	-0.29	1.50	0.63	-0.29
E2e	1.98	0.64	2.33	0.72	0.55	2.10	0.44	0.19	1.75	0.79	-0.36	1.91	0.68	-0.11	1.87	0.34	-0.17
E2f	2.02	0.65	2.07	0.80	0.08	2.14	0.48	0.18	2.10	0.72	0.12	2.02	0.65	0.00	1.69	0.60	-0.51
E2g	2.04	0.72	2.07	0.70	0.04	2.57	0.68	0.74	1.90	0.55	-0.19	1.64	0.66	-0.56	2.06	0.68	0.03
E2h	2.07	0.70	2.47	0.91	0.57	2.24	0.54	0.24	2.10	0.55	0.04	1.68	0.78	-0.56	2.00	0.36	-0.10
E2i	1.78	0.67	2.00	0.76	0.33	1.81	0.60	0.04	1.95	0.89	0.25	1.59	0.50	-0.28	1.56	0.51	-0.33
E2j	2.11	0.75	2.27	0.80	0.21	2.29	0.64	0.24	2.10	0.64	-0.01	1.77	0.87	-0.45	2.19	0.75	0.11
E2k	1.88	0.83	2.20	0.94	0.39	2.26	0.81	0.46	1.80	0.83	-0.10	1.55	0.74	-0.40	1.67	0.62	-0.25
p1a	2.47	1.20	2.80	1.21	0.28	2.95	0.86	0.40	2.50	1.20	0.02	2.09	1.02	-0.32	2.00	1.40	-0.39
p1b	2.29	1.13	2.53	1.30	0.21	2.29	0.90	0.00	2.15	1.20	-0.12	2.45	1.22	0.14	2.00	1.10	-0.26

p2a	1.87	0.72	2.07	0.46	0.28	1.81	0.51	-0.08	1.75	0.85	-0.17	1.77	0.61	-0.14	2.06	1.10	0.26
p2b	1.89	0.74	1.93	0.70	0.05	1.95	0.50	0.08	1.85	0.93	-0.05	1.82	0.73	-0.09	1.94	0.85	0.07
p2c	1.77	0.71	1.60	0.63	-0.24	1.81	0.40	0.06	1.85	0.93	0.11	1.77	0.75	0.00	1.75	0.77	-0.03
p2d	1.73	0.79	1.73	0.88	0.00	1.71	0.56	-0.03	1.85	1.10	0.15	1.68	0.65	-0.06	1.69	0.79	-0.05
p2e	1.90	0.78	2.00	0.76	0.13	2.19	0.60	0.37	1.75	0.97	-0.19	1.82	0.79	-0.10	1.75	0.68	-0.19
p2f	1.74	0.83	2.07	0.88	0.40	1.90	0.70	0.19	1.70	1.03	-0.05	1.55	0.60	-0.23	1.56	0.89	-0.22
p2g	1.86	0.80	1.87	0.83	0.01	2.14	0.73	0.35	1.90	1.02	0.05	1.59	0.59	-0.34	1.81	0.75	-0.06
p2h	1.95	0.79	2.13	0.91	0.23	2.10	0.62	0.19	1.85	1.04	-0.13	1.68	0.65	-0.34	2.06	0.68	0.14
p2i	1.71	0.73	1.67	0.62	-0.05	1.71	0.46	0.00	1.80	0.95	0.12	1.73	0.77	0.03	1.63	0.81	-0.11
p2j	1.78	0.78	2.00	0.84	0.28	2.05	0.50	0.35	1.75	0.97	-0.04	1.59	0.73	-0.24	1.50	0.73	-0.36
p2k	1.70	0.79	1.67	0.82	-0.04	1.81	0.60	0.14	1.70	0.98	0.00	1.73	0.77	0.04	1.56	0.81	-0.18
q5_com	0.71	0.45	0.67	0.49	-0.09	0.76	0.44	0.11	0.65	0.49	-0.13	0.77	0.43	0.13	0.69	0.50	-0.04
q5_dig	0.65	0.48	0.73	0.46	0.17	0.81	0.40	0.33	0.65	0.49	0.00	0.55	0.51	-0.21	0.50	0.52	-0.31
q5_vid	0.39	0.50	0.47	0.52	0.16	0.48	0.51	0.18	0.60	0.50	0.42	0.27	0.46	-0.24	0.13	0.34	-0.52
q5_mp3	0.77	0.43	0.80	0.41	0.07	0.86	0.36	0.21	0.65	0.49	-0.28	0.73	0.46	-0.09	0.81	0.40	0.09
q5_lap	0.66	0.48	0.53	0.52	-0.27	0.90	0.30	0.50	0.75	0.44	-0.02	0 .45	0.51	-0.44	0.63	0.50	-0.06
q5_gam	0.64	0.48	0.47	0.52	-0.35	0.71	0.46	0.15	0.75	0.44	0.23	0.50	0.51	-0.29	0.75	0.45	0.23
q5_mob	0.83	0.45	0.73	0.46	-0.22	1.00	0.55	0.38	0.80	0.41	-0.18	0.73	0.46	-0.22	0.88	0.34	0.11
q5_web	0.48	0.50	0.53	0.52	0.10	0.62	0.50	0.28	0.60	0.50	0.64	0.32	0.48	-0.32	0.31	0.48	-0.34
q6	4.26	12.7	2.92	0.28	-0.11	8.48	26	0.33	0.60	0.56	-0.29	3.00	0.00	-0.10	2.81	0.54	-0.11
q7	2.72	13.1	1.33	0.99	-0.11	7.14	26	0.34	1.0	0.00	-0.13	1.06	0.24	-0.13	1.44	0.81	-0.10
q8mon	75	71	34	54	-0.58	119	80	0.62	71	85	-0.06	79	61	0.06	57	33	-0.25

q8tue	77	73	76	70	-0.01	117	73	0.55	60	90	-0.23	79	64	0.03	45	34	-0.44
q8wed	82	75	69	64	-0.17	122	87	0.53	78	89	-0.05	77	65	-0.07	55	38	-0.36
q8thu	76	74	37	53	-0.53	114	87	0.51	75	89	-0.01	80	66	0.05	56	28	-0.27
q8fri	87	81	73	65	-0.17	99	72	0.15	89	95	0.02	84	65	-0.04	83	107	-0.05
q9	1.25	0.50	1.22	0.44	-0.06	1.48	0.60	0.46	1.14	0.36	-0.22	1.25	0.58	0.00	1.07	0.26	-0.36
q10a	2.20	0.81	1.92	0.90	-0.35	2.38	0.74	0.22	2.35	0.79	0.19	1.74	0.81	-0.57	2.56	0.63	0.44
q10b	1.90	0.88	2.27	0.90	0.42	1.95	0.92	0.06	1.81	0.83	-0.10	1.84	0.83	-0.07	1.75	0.93	-0.17
q10c	1.11	0.35	1.00	0	-0.31	1.10	0.44	-0.03	1.25	0.45	0.40	1.05	0.23	-0.17	1.13	0.34	0.06
q10d	1.48	0.74	1.18	0.40	-0.41	1.48	0.75	0.00	1.69	0.70	0.28	1.32	0.67	-0.22	1.69	0.95	0.28
q10e	1.72	0.70	1.45	0.69	-0.39	1.71	0.64	-0.01	1.94	0.77	0.31	1.74	0.73	0.03	1.69	0.70	-0.04
q10f	1.19	0.50	1.00	0.00	-0.38	1.10	0.30	-0.18	1.38	0.62	0.38	1.37	0.76	0.56	1.06	0.25	-0.06
q11a	2.80	0.50	2.64	0.67	-0.35	2.81	0.40	-1.57	2.87	0.34	0.15	2.78	0.55	3.18	2.87	0.34	3.36
q11b	1.26	0.46	1.18	0.40	-0.17	1.33	0.58	0.15	1.50	0.56	0.51	1.06	0.24	-3.78	1.19	0.40	-3.50
q11c	1.37	0.47	1.18	0.40	-0.29	1.24	0.54	-0.20	1.56	0.73	0.29	1.17	0.38	-0.19	1.69	0.95	0.91
q11d	1.71	0.66	1.45	0.69	-0.43	1.71	0.46	0.00	1.87	0.62	0.27	1.50	0.62	0.20	1.94	0.57	0.86
q11e	1.33	0.60	1.55	0.69	0.40	1.30	0.46	-0.07	1.25	0.45	-0.15	1.17	0.39	-0.90	1.50	0.73	-0.35
q12a	1.09	0.29	1.18	0.40	0.31	1.00	0.00	-0.31	1.13	0.34	0.14	1.17	0.38	0.28	1.00	.000	-0.31
q12b	1.20	0.43	1.27	0.47	0.16	1.10	0.30	-0.23	1.13	0.34	-0.16	1.28	0.57	0.19	1.25	0.45	0.12
q12c	1.23	0.53	1.18	0.40	-0.09	1.29	0.56	0.11	1.44	0.73	0.40	1.00	0	-0.43	1.25	0.58	0.04
q12d	1.09	0.28	1.27	0.47	0.64	1.10	0.30	0.04	1.06	0.25	-0.11	1.06	0.24	-0.11	1.00	.000	-0.32
q12e	1.44	0.63	1.27	0.47	-0.27	1.62	0.67	0.29	1.56	0.73	0.19	1.17	0.38	-0.43	1.50	.730	0.10

q12f	2.68	0.70	2.36	0.92	-0.46	2.90	0.44	0.31	2.87	0.50	0.27	2.33	0.91	-0.50	2.81	.544	0.19
q13_wp	3.56	0.72	3.83	0.41	0.38	3.43	0.75	-0.18	3.69	0.62	0.18	3.59	0.79	0.04	3.47	0.83	-0.13
q13_ss	3.09	0.81	3.50	0.55	0.51	2.86	0.80	-0.28	3.25	0.58	0.20	3.12	0.93	0.04	3.07	0.96	-0.02
q13_db	2.71	1.04	3.83	0.41	1.08	2.90	0.77	0.18	2.38	1.15	-0.32	2.88	1.17	0.16	2.33	1.11	-0.37
q13_sl	3.51	0.73	3.83	0.41	0.44	3.48	0.68	-0.04	3.63	0.62	0.16	3.59	0.80	0.11	3.20	0.86	-0.42
q13_em	3.57	0.72	3.83	0.41	0.36	3.48	0.75	-0.13	3.56	0.73	-0.01	3.65	0.70	0.11	3.53	0.83	-0.06
q13_fm	3.53	0.78	4.00	0	0.60	3.29	0.78	-0.31	3.50	0.90	-0.04	3.59	0.71	0.08	3.67	0.82	0.18
q13_in	3.72	0.63	4.00	0	0.44	3.62	0.80	-0.16	3.75	0.45	0.05	3.76	0.43	0.06	3.67	0.82	-0.08
q13_wa	3.08	1.04	3.50	0.84	0.40	2.81	0.93	-0.26	2.63	1.02	-0.43	3.29	1.05	0.20	3.53	1.06	0.43
q13_dp	3.39	0.77	3.83	0.41	0.57	3.24	0.94	-0.19	3.44	0.63	0.06	3.47	0.72	0.10	3.27	0.80	-0.16
q13_ie	3.51	0.72	3.83	0.41	0.44	3.33	0.73	-0.25	3.31	0.95	-0.28	3.59	0.62	0.11	3.73	0.60	0.31
q13_dv	2.92	1.00	3.17	0.98	0.25	2.81	0.87	-0.11	2.56	1.03	-0.36	2.94	1.03	0.02	3.33	1.05	0.41

Appendix L - Open item responses – Best Engineering exam

Best things about doing the Engineering Exam

GE-15 Students	HE-21 Students	LE-12 Students	RE-14 Students	WE-22 Students
Easier to see what is being talked about (pictures etc.). No waste of paper.	Photographs. Voice recording.	Can read if you have bad handwriting. Recording videos supplies a more detailed response.	Less writing. Easy to edit.	Was interesting. Relevant to real world in using computer for design.
Steps are easier to follow. Easier to type than write our generation).	Easy to put things together. Can be edited easily.	It was simple. That it is easier to type than to write for a long time.	Typing. Drawing.	Quick. Efficient.
Easier to express what I'm thinking. More interesting.	Much easier. More accurate make expressing some ideas easier.	Can do audio and video. Can type neater than handwriting.	Fun. Fun Easier.	Easy and faster to write out comments. Documenting is fast and efficient.
Faster. I can express what is in my head.	Compiling the portfolio. Easy to use and understand.	Easy to write more quickly. Not stressful	More relaxing. Typing rather than writing.	Ease of use. Helps with design. Easy to get ideas across.
Was neater than my handwriting. Able to show exactly what I meant.	Easy to use layout. Simple format. The computer does the work for you buddy.	Everyone does it at the same time. Easy to mend mistakes.	Engaging. Efficient. Real-life setting. Easy to read.	A lot faster to type using keyboards. Fast.
It evaluates a more hands on and class like environment. It was what we do in class.	The computer does the work for you. Made positive use of available technology.	Allows quick referencing between parts. Easy to understand.	Easy to change. Different. Easy, straight forward. No writing.	Easier to develop ideas. Step of thinking followed.
Step by step Each step has set time.	Potential change in exam, which I believe, will be positive. Compiling portfolio.	Fast to record data. It's the way of the future. It's easier to read my writing.	Little prac. No paper. Drawing.	Easy to record idea and to apply them. Easy to understand questions with detailed diagrams.
It is easy to fix up mistakes. It was easy to record and take pictures.	Steps outlined. Fast. Opens possibilities. Easy to use and understand.	It was good because it doesn't matter if you have a dodgy pencil. No written exam.	Fun. Different. Typing is faster. Easy to use. Easy to edit. Less writing.	Use of camera allows simple and detailed answers within a small time frame.
It's easier to show my opinion and ideas. It wasn't a boring,	It is faster by typing. I am typing so handwriting is easy to read.	Interesting. It was a lot quieter and easier.	By typing people can read what you wrote.	It was easier to follow. It was fun.

tedious task that required study. Instead, it required our innovative thinking.

The webcam video and recording to explain your idea. Ability to take photos of your design.

It was quick and easy to use. It was clearer.

Step by step guide. Easy to use.

Fun. More practical rather than theory.

Building models. Cameras.

I can type faster than I write which saves time. Don't have to flip pages back and forward to view questions.

Can go back and change things easier. Missing other classes.

Making the design. Easier to use in comparison to pen and paper.

Found it quite easy to develop ideas. Quick and easy to type as opposed to writing which gave me more time to develop my ideas.

Made exam more fun and interesting than using paper. Quick. Easily remove errors. Easy to record ideas.

Faster to write up stuff. Quick. Efficient.

We took a video. This was a new idea that I welcomed.

I can type faster than I can write. Ability to take photos.

Easy to edit work

It was better to use computers than writing it down.

Quicker to type. Easy steps and a timer to keep track of activities.

It was fun. It was easy to keep portfolio.

Don't have to write as much. Connected with all others well.

Faster than writing. Able to easily upload pictures.

You don't need to write as much. No response.

Easy to use. Less stressful. Easy to write.

Simple. No response. No response.

Developing ideas. The computer makes it easy to type.

The use of video/photo recording. Using a webcam.

Easy to use. No response.

No response. Typing responses.

Fun and new. It was neat and easy.

Appendix M - Open item responses – Worst Engineering exam

Worst things about doing the Engineering Exam

GE-15 Students	HE-21 Students	LE-12 Students	RE-14 Students	WE-22 Students
People can look at answers and can take ideas.	Time limits.	Technical issues.	Less writing.	The camera's quality made me feel my ideas were not properly understood.
My ergonomics is bad so sitting in front of a computer for 3 hours hurts.	Takes longer to get used to.	Drawing pictures.	Easy to edit.	Programming plans was a hassle at some points made it slow to write/produce my ideas.
	When evaluating others work setting out text was difficult.	It took too long to do stuff.	Typing.	
	Computer problems and bugs.	It is really hard to go back to questions.	Drawing.	Fiddly. Small.
Lack of control (forced to stay on same section of exam).	Took a long time waiting for everyone to finish each section so that we could proceed.	If there is a problem with the computer will be bad.	Fun.	Not much freedom. Time limit on each question.
			Fun.	Time limits.
No response.	Lack of personality (everybody's portfolio looks the same so they are sort of brought to a similar level).	Hard to use a low quality webcam to show drawings.	Easier.	Computer screen too small.
Time limitations.			More relaxing.	
Picture quality.	Editing programs are hard to use.	Limited time allocation to do the exam.	Typing rather than writing.	Couldn't edit as well. Distracting with available games.
Technical issues.	Many technical errors.	Camera quality wasn't good enough.	Engaging.	Computer malfunctioned - I was not able to do a step.
Picture quality.	Step time restraints.	Couldn't edit photos after they were taken.	Efficient. Real-life setting.	We could play games on them, which distracted us.
Lack of privacy.	Step time restraints.			
		Confusing at times.	Easy to read. Easy to change.	Sometimes the camera failed.
A little bit too high tech for me.	Using webcam to record video had no audio.	Doesn't feel satisfying.	Different.	Takes time to understand what each function is.
	Too many required changes in design.	The camera and related program are difficult to use.	Easy, straight forward.	A little less time than I needed.
Time limits.	Time and waiting for everyone to			Too small (computer screen).

Picture quality.

Writing text was sometimes hard.

Time on each step was either too much or too little.

It was frustrating when the slides changed without finishing.

No response.

The text box fault - you can't go back to a text box and edit it.

My computer froze once.

The time.

Mode.

Some things were hard to use.

Timing a bit out.

Froze once.

Model.

Time limit.

Computers logged out sometimes.

complete.

Lack of personality.

Technical issues.

Explanations.

Was the quality taking of the photos.

Not enough time to build and materials.

It was buggy and crashed out.

The camera was fairly impractical.

Webcam presentation.

Not enough time per building design.

Was hard to use the font tools properly because of the layout style, (text boxes were difficult).

Data transfer via image capture was hard to interpret on computer screen. Images not very detailed.

Technical issues.

Strict times.

You had to retype all sentences in the box if it was wrong.

Painful to set up.

Couldn't work at own pace.

The occasional crash makes the work inconvenient.

Because it was the first time I was not prepared.

Some of the fact book things were annoying.

Having to wait for people.

Webcams were blurry.

Easy to get distracted by internet games.

No response.

Computer malfunctions.

None other.

My computer kept screwing up and had to reset it twice.

No writing.
Little prac.

No paper.

Drawing.

Fun.
Different.

Typing is faster

Easy to use. Easy to edit.

Less writing.

By typing people can read what you wrote.

System errors e.g. it froze.
Not being able to edit and not go at your own pace.

Webcam died.

The keys were too small.

Hard to move/keep camera stable.

Camera is a tad slow. Computer froze.

You must take pictures of your pencil designs.
I don't like being filmed.

Each question has a limited amount of time whereas in a test no restrictions.

Can't label.

Can't advance (waiting for others).

Small computers. Unclear webcam pictures.

Too hard.

Speed at which you can do things.
Performance of computers.

The camera was not very sharp.

Small keyboard. Slightly slower.

Harder to draw my designs.	Technical issues.
	Limited time.
No response.	Computer lags sometimes.
	The whole set up was unpredictable and at times frustrating.
	I feel limited when using a computer.
	All the technical problems that occurred setting up the programs.
	Slow (webcam had to get the right amount of time, freezes, lots of time).
	Not reliable - network wasn't responding, drawing tools was like Paint where the text boxes were permanent, couldn't log in sometimes.

Appendix N - AIT Assessment Task – Digital Portfolio and Exam

Digital Reflective Process Portfolio

A digital portfolio to contain:

(1) A digital product the student has designed as a prototype of an information solution.

(2) The design process document for that digital product.

(3) Two other digital artefacts that illustrate skills in two areas from a specified list.

Portfolio (Component 1) -The Digital Product

Create a prototype of an information solution in the form of a digital product relevant to a business context and using applications software commonly used in organizations for productivity, planning and communication (e.g. word processing, publishing, presentation and financial data management). A technology process should be employed in the investigation, design, production and evaluation of the product. Output from these processes will be required for the Design Process Document and therefore the requirements of this document should be used to guide the technology process. The digital product should:

suit the intended purpose and audience/users;

meet the requirements of the design brief and/or client specifications;

illustrate creative application of information design principles and technologies;

make use of appropriate information structures, forms, layouts and symbols;

employ relevant standards and conventions to create multi-tiered information solutions; and

use appropriate methods and techniques to represent the design of information solutions.

The digital product will be delivered in a single digital file with one of the following formats: PDF, AVI, JPG, GIF, SWF, FLA, HTML or ZIP (must be a collection of files with the permitted formats e.g. zipped folder of a website of HTML and FLA files). The file will not exceed 60MB. The product must have been produced at school using hardware and software provided by the school and represents no more than 16 hours work.

Example Design Brief

Miss Shoppe is the manager at a local retail clothes outlet. She is very concerned with the increasing number of people shopping online and the declining number of consumers venturing into her shop to purchase her products. The shops target market is teens (12 – 20 years). She has approached you to create her own online shop front. She would like the website to include general information regarding the shop (Open hours, Products, Location), contact details (Location, Telephone number, Email address) and an online catalogue (List of products, Bulletin Board, Mailing List, Current News). Her corporate colours are Green, White and Black.

Using this information, design the online presence for Miss Shoppe. Miss Shoppe has requested that you present your designs as detailed storyboards and provide a summary of recommendations that you have made. Miss Shoppe has also requested that a detailed production plan be developed.

Select your best design and develop a website that will allow her shop to have an online presence as a means of contacting her target audience, promoting her business and potentially selling more products. Use any suitable software to create the website and any suitable media, taking care to appropriately acknowledge the source of any media you use.

Portfolio (Component 2) – The Design Process Document

Over a period of six hours during two weeks students will collate a document with a maximum of nine pages as a single PDF file that comprises four sections, Research, Design, Production and Evaluation.

Research document will present (recommend no more than two pages) the results of their investigation of solutions to the information design problem to include:

An outline of the human need or opportunity that was addressed.

The main objectives of the information solution.

Brief descriptions of existing solutions and what aspects needed improving and thereby the criteria that could be used to evaluate the success of their own solution.

A summary of the strategies that were used to find and analyse relevant information to generate ideas including methods such as brainstorming and mind-mapping.

Design document will present (recommend no more than four pages) the final design and design processes to include:

Adequate information that would allow another skilled person to complete the production such as descriptions, storyboarding and concept development processes such as thumbnail sketches, annotations, photographs, drawings, flowcharts and schematics developed to represent the design.

Examples of early attempts, which were subsequently improved with explanation of the improvements.

An explanation of how they applied technologies in creative and original ways to meet the need, considering purpose, meaning, target audience and client specifications.

Production document will present (recommend no more than two pages) a plan of project management, activities, sequencing and logistics, to include:

The production plan for the prototype solution including the key decisions, acknowledging contextual influences, the use of design elements, standards and conventions and justification of tools used. A list of the hardware, software, materials and personnel resources employed.

Descriptions of the skills and understanding that were needed to apply the hardware and software.

Evaluation document will present (recommend no more than one page) the evaluation of the prototype information solution and technology processes employed, to include:

An explanation of how the information solution was evaluated.

A summary of the results of the evaluation reflecting on the strengths and weaknesses of the solution.

Portfolio (Component 3) -Two Extra Digital Artefacts

Two digital artefacts should be submitted that illustrate the student's skills in applying design principles in any two of the following domains … graphics, databases, spreadsheets, web-publishing etc. The digital artefacts must have been created by the student, at school, under supervision from the teacher. Any assistance from the teacher or others must be explained. The digital artefacts must include a document of no more than one a page in length (combined) describing for each artefact what hardware, software, techniques and skills were needed to create the artefact original image and then use some of the other photographs;

video and/or audio to enhance the presentation – at least one video or audio file must be used;

the inclusion of the feedback form; and

the quality of the finished product.

Make any notes clearly as the designs will be scanned for assessment. Put your candidate number at the top of each page.

Task 2: Selecting Video Segment(s) (suggested time 5 minutes) (2 marks)

Select at least one video and audio from the sample files to be used in your shopping centre display (either Option A: as part of your interactive display or Option B: continuously displayed on a monitor).

Create a submission folder on the USB flash drive called <your ID>–exam.

For both options you must put the selected video and audio segments into your submission folder.

Task 3: Graphs (suggested time 15 minutes) (5 marks)

In the file data.txt there was some data from your school and data from other schools in your state. Use this data to create a spread sheet that utilises at least two formulae and generate at least two charts to be used in your school's display. These charts should communicate positive aspects of your school to the target audience. Save the spread sheet file with the charts included as charts.xls on the mass storage device provided.

Task 4: Images (suggested time 20 minutes) (4 marks)

Using only the digital photographs supplied and your own ideas, develop at least one original image for your interactive computer display (Option A) or for your poster (Option B). Do not create more than three original images.

Save the images as image01.jpg, image02.jpg, etc into your submission folder.

Task 5: Feedback Form (suggested time 15 minutes) (4 marks)

You need to provide the opportunity for viewers of your display to request further information and provide feedback on the usefulness of your display (whether Option A or Option B). Design and create a form for your

shopping centre display that will either be part of your interactive display as an interactive form or as a paper form to fill out and place in a box. If you are doing Option B you must do a paper form but if you are doing Option A you could do either an interactive form or a paper form.

Apply information design and data processing principles in designing your form. For a created paper form save it in its original format and as form.pdf into your submission folder.

Task 6: Prototype Assembly (suggested time 30 minutes) (6 marks)

Take one of your design ideas, using the supplied files and those from the previous tasks (video, graphs, images), and any software available on your workstation assemble your display. Save the file as display (the file extension will depend on the software you use) on the mass storage device provided. For the poster also save it as display.pdf and for the interactive display put all files used in a folder and compressed it to a single file display.zip

Task 7: Reflection (suggested time 15 minutes) (5 marks)

Reflect on your work using the provided document reflection.doc as a template. Save this into your submission folder. As you work through this document you will:

identify the purpose and the target audience of your product;

explain and justifies your selected design choices (this includes a critique on the design principles and elements you have incorporated);

comment on the file sizes and types of the files, published as part of your display;

state how your own created image/s enhanced your message;

state why you selected the video and audio segment;

evaluate the effectiveness of conveying information about the School through this product when comparing the two methods (Options A and B from Task 1) of conveying information.

Submission checklist (3 marks for submission of correct files)

All students are to save all files in the following formats as per instructions

Save or submit your design ideas for your presentation, as sketches and notes (on paper or as an electronic file named plan_template.doc)

For students who chose Option A or B, save your interactive computer display as the following in your Candidate Folder with the appropriate file extensions. Such as XX.htm or .ppt with links to other files, and display auto run shortcuts if required.

Files such as feedback forms, and spread sheet chart should be embedded in interactive computer display, this means that they will most likely be saved in same folder as XX.html files, along with the video files.

Component 4 Performance-based Exam

Students completed a set of scripted tasks at a computer workstation over a two-hour period under 'exam' conditions. This comprised a set of short performance tasks associated with a common scenario as the digital portfolio, but for a different design brief listed below.

The Design brief

Ms Ely Petrie, Marketing Coordinator for your school, has approached you for ideas in presenting information, in the form of a promotional shopping Centre display, about the school to the local community. The promotion will be staged at a nearby Shopping Centre. To determine the success of your promotion an evaluation form will be submitted by shopping Centre customers.

Appendix O - Engineering Assessment Task

The task was presented to the students in the following manner:

> The context for this task is a family camping at a remote beach.
>
> They were dropped off at the beach and will not be picked up for another 2 weeks, so they have no transport and no means of contacting the outside world.
>
> They have run out of fresh drinking water, and there is no water around and so they need to invent a process to make seawater into drinking water.
>
> They have no power, so must depend on the heat and energy from the sun.

'e-Scape' was used as the tool to design and present the task to the students. This is a program that enables the design of a portfolio template into which students can input a range of forms of data – text, graphics, voice and video. Stimulation material and instructions can be designed into the portfolio, each task (or portfolio 'page') can be timed and collaborative activities can be set up so students critique aspects of each others' designs and then respond to their peers input. The following are two examples of 'e-Scape' pages.

The students were required to do some sketching of their ideas on paper, and then they took a picture of their sketch to include in their e-Scape portfolio. A paper template was prepared for this purpose, folded to promote the sequence of activities required, and printed on 2 sides of an A3 sheet. For example:

Box 16 Presentation Points	Box 5 1st Sketch

Engineering Digital Examination
 	
        Student Login: fe101
        Password: eng12
        School:
	Box 11 3rd Sketch
	(Final sketch before modeling)
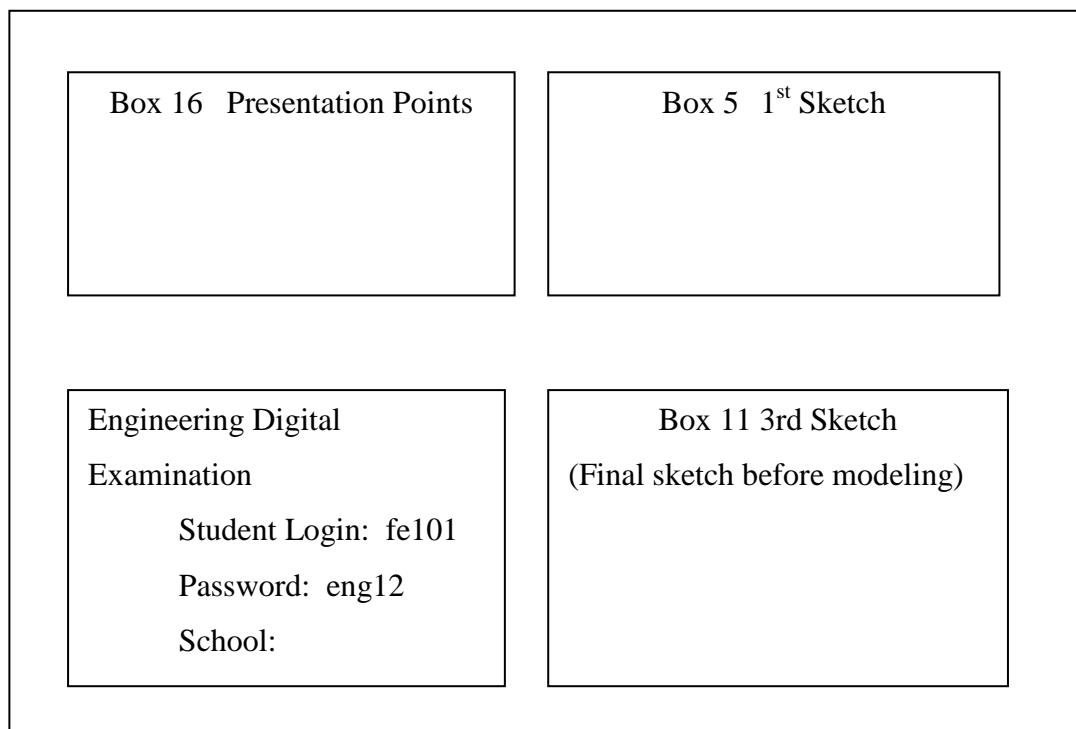
This process was managed through the first activity in their examination portfolio, but before the examination actually began. The following extract from the running sheet indicates the process:

> Take a picture
>
> When you (Click Here...) choose the option (New).
>
> When taking a picture with the USB camera:

Write on the front of the booklet

Make sure the paper is flat

Focus the camera

Include all the page in the picture

Click on (Take Picture)

Click on (Save and close)

Draw on the picture

Click on the pencil to draw lines (you can change its thickness and colour)

You can 'undo' in the Edit drop down menu

Type in the box

Click on the T to write text

Highlight the auto text

Type your comments (you can change font size)

No carriage return

Intranet.

Each student was allocated a mini computer (ASUS EePC) for use in completing the engineering task. The battery on these computers lasts for about 3 hours, and because that is the length of the task, it was judged as inadequate for the time period hence the power cables were used. Each computer was additionally accompanied by an external camera and mouse.

The ASUS Ee pc with

peripherals attached

Live.

Each student worked on one of the school computers and logged directly in to the examination server. Some computers did not have an external camera attached, so these had to be supplied by the researchers and tested beforehand to ensure the run software recognized the camera.

The webcam was also used by the students to take pictures of both their models. For this purpose the camera could be removed from the stand and oriented to take a picture of the required features.

A student using the USB camera to take pictures of his model.

Appendix P - Open Item Responses – AIT – Best things about the AIT Exam

Best things about doing the AIT Exam (E3 & E4)

NA-15 Students	OA-21 Students	VA-20 Students	XA-23 Students	ZA-16 Students
No writing. Faster It is quicker. It is easier to design.	Create graphics, graphs and display. Quicker than writing.	. The computer. AIT teacher help.	Less writing. Easy to edit.	I was on the computer. I'm better at applied versus theory.
Less hand cramps. Faster completion time.	Able to use software to reflect our design.	Exams feel less stressful. Easier to complete exam. People too close to each other.	Typing. Drawing. Fun. Fun Easier.	Got to use computer. Not too much writing.
Allowed better development of ideas. No response.	Able to use technology in an Applied Technology exam.	Computer was slow. Unused to it. Computers can freeze.	More relaxing. Typing rather than writing. Engaging. Efficient.	Using computers. Air conditioning. Air conditioning. Practical exam.
Faster way to put my designs into final documents. Lots of resources (Photoshop).	It was on a computer. The materials were all there and ready in different formats.	Do not use Macintosh computers. They lag way too much.	Real-life setting. Easy to read. Easy to change. Different.	Get to show examiner what we can do on a practical level. Also get to show examiner on theoretical level.
No need to write. Computers are easy to use.	More efficient. Can erase mistakes without the mess.	Mac computers. Not enough time.	Easy, straight forward No writing. Little prac. No paper.	More efficient than on paper. Faster and more efficient than on paper. Easier to produce documents. Show our skills.
Easy to write long answer questions. It was a bit free work because it was new to me.	Less quiet. More convenient.	Possible crash. Macintosh ID	Drawing. Fun. Different. Typing is faster.	Good graphics. Quicker. Easier. Appeals to the knowledge most teenagers have.
Don't have to write with my hand. Save paper.	It wasn't factual recall so much as applying skills one has with a computer.	Distractions. Computers lag almost every time I perform a task.	Easy to use. Easy to edit. Less writing. By typing people can read what you wrote.	More efficient. The use of computer design software like Fireworks and Photoshop.
Easy to create designs and we can use a variety of content.		Longer to create ideas.		The computers made answering the reflection much easier. Everything we needed was structured on the computer.
Make multiple designs		Lot more work.		

409

quickly. Easy access to information. Able to search for info.

Is a cooling area and friends are around me instead of working by myself. Able to get help from friends.

More reflective of our classwork - tasks etc. rather than completing written work.

To view the graphics on the USB and the media.

Writing out the plan on the sheets of paper.

It was productive and much quicker.

It was easier and not time consuming.

It's faster to complete.

Easier because you get to type it up.

Easy to create the final product.

Helps show ideas more clearly.

Learn how to show work graphically.

Able to create ideas into the exam rather than writing.

That the computers may crash.

Detail in steps.

Designing.

Kept freezing.

Could have lost the data.

Hard to understand some questions.

There isn't enough time.

Computers can crash.

Macs.

Load times.

It was a lot more enjoyable. Using computers than paper.

I am better at using the computer for design so that helped me a lot. It was a familiar and good exam (designing a website). Easy to change design ideas. Easier for designing.

Saves time compared to writing.			
More relaxing. More comfortable.			
Designing our ideas on computer.			
Producing final product on computer.			
It was neater and easier to put all the work together.			
It was quicker than writing.			
Able to pursue ideas by using technology.			
Pretty easy to follow, neat and quicker.			
Easy to type out work.			
Easier to set out the exam on the computer with pictures than paper.			
Easier to work on.			
Different. Nice			

	experience.			
	More relevant to the work we do in class.			

Appendix Q - Open Item Responses – Worst things about the AIT Exam

NA-15 Students	OA-21 Students	VA-20 Students	XA-23 Students	ZA-16 Students
Difficult to sketch on computer.	Answering questions.	People too close to each other.	It was really cold.	Time.
Must try to get used to it.	Hard to follow the instructions, questions not outlined clearly.	Computer was slow.	Nothing.	Time limit.
Lack of reliability.		Unused to it.	None.	Confusing folder structure.
Using only what was given.	Some people are not quick typists, they write quicker.	Computers can freeze.	None.	Not enough time.
Uploading the work after.		Do not use Macintosh computers. They lag way too much.	It was too long.	Walking here.
Not finding/being able to open files.	The computer was not good for the software i.e. the image manipulation.	Mac computers.	Got boring.	Only confined scope in what we do with computer -website, poster.
Took too much time.		Not enough time. Possible crash.	More distractions.	For those better at theory, harder for them to create.
Not being able to open files.	Certain formats didn't work which was confusing.	Macintosh ID	Less formal.	Not enough time.
Couldn't follow the instructions properly.	Lots of typing noise, not too quiet.	Distractions.	None.	Small mistakes can't be corrected easily sometimes.
Tires my eyes.		Computers lag almost every time I perform a task.	None.	Sometimes too time consuming to do each step.
Some resources provided (photos) are not so useful.	The numerous tasks were fairly long winded when the actual thing they required you to do was basic, it instilled confusion.	Longer to create ideas.	My computer froze for a bit.	Steps.
Cannot design to the best of my abilities.		Lot more work.	Slow computers.	Dreamweaver was annoying in its need to be micro-managed to get a good result.
Uploading my work.		That the computers may crash.	I found it hard to create ideas.	I am unable to show my true design skills.
		Detail in steps.	I found it hard to understand some of the questions.	
		Designing.	Computer freezing or slow. Saving process might go wrong and might not be saved.	Computer problems.
	Accessed skills	Kept freezing. Could have lost the data.	Time to upload files.	Complications with programs

413

Not enough time.

Can't find any really - nothing was bad.

Just hurts your eyes a bit.

Using software that I don't know how to use.

Bothering to make files and save stuff.

Not enough time to design properly and make a prototype.

The designs were not as good as the ones on paper.

No space for paper and pen.

Distractions.

like Excel with which not everyone is accustomed to.

I didn't understand what to do first.

It was hard to choose the data eg picture, video etc.

The questions didn't make sense. It wasn't explained very well.

It wasn't easy to follow the steps for the exam on computer.

It was confusing (the instructions).

Problems with computers.

Possible "cheaters".

Computers were close together.

Not knowing how to use software.

Crash on computer, any unsaved work deleted.

Hard to understand some questions.

There isn't enough time.

Computers can crash.

Macs.

Load times.

sometimes.

Not enough time.

Not enough time.

Some things can go wrong.

Time was a bit short.

414

Hard to understand.

Complications with equipment

Software not responding.

Computers were slow.

It was more difficult to understand the exam.

Some things were too overwhelming

Moving files and work was a bit confusing.

Confusing.

Some instructions were hard to follow.

Moving files and work was a bit confusing.

Setting the work out.

The questions aren't on the computer it's on

paper.

I had to do it.

Somewhat
confusing.

Hard to switch to a
computer based
exam.

The instructions
were confusing.

It included stuff
we didn't cover in
class - Excel.

Appendix R - Open Item Responses – AIT – Best things about the Portfolio

Best things about doing the Digital Portfolio – Best things about the Portfolio

NA	OA	VA	XA	ZA
Easier to see what is being talked about (pictures etc). No waste of paper.	Photographs. Voice recording. Easy to put things together. Can be edited easily.	Can read if you have bad handwriting. Recording videos supplies a more detailed response.	Less writing. Easy to edit.	Was interesting. Relevant to real world in using computer for design.
Steps are easier to follow. Easier to type than write our generation.	Much easier. More accurate make expressing some ideas easier. Compiling the portfolio.	It was simple. That it is easier to type than to write for a long time. Can do audio and video. Can type neater than handwriting.	Typing. Drawing. Fun. Fun Easier. More relaxing. Typing rather than writing. Engaging.	Quick. Efficient. Easy and faster to write out comments. Documenting is fast and efficient.
Easier to express what I'm thinking. More interesting. Faster. I can express what is in my head.	Easy to use and understand. Easy to use layout. Simple format. The computer does the work for you buddy.	Easy to write more quickly. Not stressful. Everyone does it at the same time. Easy to mend mistakes.	Efficient. Real-life setting. Easy to read.	Ease of use. Helps with design. Easy to get ideas across. A lot faster to type using keyboards
Was neater than my handwriting. Able to show exactly what I meant.	The computer does the work for you. Made positive use of available technology. Potential change in exam, which I believe, will be positive.	Allows quick referencing between parts. Easy to understand. Fast to record data. It's the way of the future.	Easy to change. Different. Easy, straight forward No writing. Little prac.	Fast. Easier to develop ideas. Step of thinking followed. Easy to record idea and to apply them.
It evaluates a more hands on and class like environment. It was what we do in class.	Compiling portfolio. Steps outlined. Fast. Opens possibilities. Easy to use and understand.	It's easier to read my writing. It was good because it doesn't matter if you have a dodgy pencil.	No paper. Drawing. Fun. Different.	Easy to understand questions with detailed diagrams. Use of camera allows simple and detailed answers within a small time frame.
Step by step Each step has set time. It is easy to fix up mistakes. It was easy to record and take pictures.	It is faster by typing. I am typing so handwriting is easy to read.	No written exam. Interesting. It was a lot quieter and easier. It was better to use computers than writing it down.	Typing is faster. Easy to use. Easy to edit.	It was easier to follow. It was fun. Quicker to type. Easy steps and a timer to keep track of activities.
It's easier to show my opinion and ideas. It wasn't a boring, tedious task that required study. Instead, it required our innovative thinking	Can go back and change things easier. Missing other classes. Making the design. Easier to use in comparison to pen and paper.		Less writing. By typing people can read what you wrote	It was fun. It was easy to keep portfolio. Don't have to write as much. Connected with all others well.
The webcam video and Recording to explain your idea.	Found it quite easy to develop ideas. Quick and easy to type as opposed to writing which gave me more time to develop my ideas. Made exam more			Faster than writing. Able to easily upload pictures. You don't need to write as much.

Ability to take photos of your design.

It was quick and easy to use. It was clearer. Step by step guide.

Easy to use. Fun. More practical rather than theory. Building models. Using cameras.

I can type faster than I write which saves time. Don't have to flip pages back and forward to view questions.

fun and interesting than using paper.

Quick. Easily remove errors. Easy to record ideas. Faster to write up stuff. Quick. Efficient.

We took a video. This was a new idea that I welcomed.

I can type faster than I can write. Ability to take photos. Easy to edit work

Easy to use. Less stressful. Easy to write. Simple.

Developing ideas. The computer makes it easy to type. The use of video/photo recording Using a webcam. Easy to use.

Typing responses. Fun and new. It was neat and easy

Appendix S - Open Item Responses – AIT – Worst things about the Portfolio

Worst things about doing the Digital Portfolio

NA	OA	VA	XA	ZA
Long process. Gets boring.	Takes time to get started, what to write, no freedom of freehand.	Took time to access files. Unused to it.	Lots of work.	Time constraints.
Uploading onto maps. Confusing to follow.	Distractions, having other people in same class typing is disturbing and doesn't allow for full concentration.	Mac computers.	Nothing else.	Run out of time.
Annoying to put everything in the folder.	A lot of written work to be done.	Macintosh.	Computer can screw up.	Time restraints.
Bothering.	Due dates were not clearly said.	Not enough time.	Problems.	Not much.
It was of a lesser quality than one done on paper.		Macintosh.	Slow computers.	If you can't design mx = 70%
Have to logon to another computer to scan my sketches.	Files that won't save properly. Possible file corruption.	Reflection.	Time was wrong on computer so was confused.	A bit confusing with subfolders and contents.
Writing journal every time I'm in Applied Technology.	Long winded - again great detail in steps in which only a simple task was asked.	Virus.	I had difficulties understanding questions.	Were no worse things I can think of.
	Choosing what to put on it. Choosing how I am going to design.	Easy to copy.	It tested me.	File types.
	The artefacts section didn't make sense, couldn't find my old files so I had to do a new one.		Creating wrongly.	Instructions.
	There were too many things to do in so little time. There shouldn't be set hours.		Might not be saved or get deleted.	A bit confusing with subfolders and contents.
	Not knowing the skills to make the portfolio.		Flash didn't end out right.	Time limit.
	Rather paper than computer.			Possibility of file loss or accidental deletion.
	Researching for ideas. Finding suitable ideas. It was slightly harder to work on it at home.			Hard copy of DVD had to accompany, possibility of getting lost etc.
				Time.

Some things were a bit confusing.

Confusing, had to read it a few times to get it.

You have to set out your portfolio yourself. Too much folders that were on the computer already.

I had to do it. Hard at first.

Wasted a lot of valuable time thinking.

It was too similar to the previous task. We weren't shown how to use web-authoring programs.

Lots of computer problems.

Complications with computers.

Not enough time.

Need a little more time to develop but the time given is ok.

Appendix T- Engineering studies student survey questionnaire

Please circle ONE response for each row.

Gender (circle): **Male** / **Female**

Doing design projects on computers

E1. (a) How often have you done a design project on a computer before?   **Lots   Some   Little   None**

(b) How much more time would you need to get used to it?   **Lots   Some   Little   None**

Doing the Engineering design project

E2. (a) It was easy to use the computer for doing the project.   **Strongly agree   Agree   Disagree   Strongly disagree**

(b) **It was easy to use the computer to develop my design ideas.**   **Strongly agree   Agree   Disagree   Strongly disagree**

(c) **The computer was a quick way for recording my design ideas.**   **Strongly agree   Agree   Disagree   Strongly disagree**

(d) **The computer was good to record my design and modelling.**   **Strongly agree   Agree   Disagree   Strongly disagree**

(e) **The computer was good for evaluating my and others design ideas.**   **Strongly agree   Agree   Disagree   Strongly disagree**

(f) **The computer was good for compiling my portfolio.**   **Strongly agree   Agree   Disagree   Strongly disagree**

(g) **It was easy to follow the steps of the design on the computer.**   **Strongly agree   Agree   Disagree   Strongly disagree**

(h) **The steps of the project helped me to develop my design ideas.**   **Strongly agree   Agree   Disagree   Strongly disagree**

(i) **Overall, the computer is a good tool for designing and modelling.**   **Strongly agree   Agree   Disagree   Strongly disagree**

(j) **Overall, I was able to show what I can do in the project.**   **Strongly agree   Agree   Disagree   Strongly disagree**

(k) Overall, it was better doing the design project using a computer than on paper.	Strongly agree	Agree	Disagree	Strongly disagree

E3.   The two best things about doing the Engineering exam using computers:

👍

👍

E4.   The two worst things about doing the Engineering exam using computers:

👎

👎

Experience and Knowledge with Computer Technology

5.   What do you use at **home?** (circle ANY of the following that apply to you)

Computer   Digital Camera Video Camera MP3 Player (e.g. iPod)

Laptop   Game Console Mobile Phone Webcam

6.   Do you have Internet access at **home?** (circle ONE)

   NO Internet   Dial-up Internet   Broadband Internet

7.   Circle the response that best describes how often you use a computer at home.

   Most Days   More than once a week   Most   Weeks
   Rarely

8.   **Estimate the amount of time in MINUTES you spent using computers at school on each day LAST WEEK.**

Monday	Tuesday	Wednesday	Thursday	Friday

9. When you type do you try to touch type (use all of your fingers)? **YES** or **NO**

10. Do you, or would you, use a computer to do the following tasks? (circle ONE for each)

  (a) Keep a list of addresses of friends. **I do I would No**
  (b) Draw a diagram or picture. **I do I would No**
  (c) Type an assignment for school. **I do I would No**
  (d) Do a line graph or pie-diagram as part of an assignment. **I do I w**
  (e) Send a letter to every sports club member or group of friends. **I do I would No**
  (f) Communicate using sites like MySpace, Facebook, Youtube **I do I would No**

11. Circle YES or SOMETIMES or NO to show whether you agree with each of the following statements.

  (a) Using computers makes the work **at school** more difficult. . . .
   . . . . **YES** or **SOMETIMES** or **NO**

  (b) I enjoy using computers **at school**. . . . .
   . . . …….. **YES** or **SOMETIMES** or **NO**

  (c) I like to use a computer **at home** to do school work. . . . . ……..
   YES or **SOMETIMES** or **NO**

  (d) I like to find things out for myself instead of being told by the teacher. …
   YES or **SOMETIMES** or **NO**

  (e) Computers are good for the world. . . . . ……..
   YES or **SOMETIMES** or **NO**

12. Circle either "YES", "Not Sure" or "NO".

423

(a) I feel confident working with computers . . …………………………….

YES   Not Sure   NO

(b) I'm good at using computers. . . . .

YES   Not Sure   NO

(c) I feel OK about trying a new problem on the computer. . . . .

YES   Not Sure   NO

(d) I usually do well with computers. . . . .

YES   Not Sure   NO

(e) I could learn to program a computer. . . . .

YES   Not Sure   NO

(f) Using a computer is very hard for me. . . . .

YES   Not Sure   NO

13. **Rate yourself on your skill level in using each of these types of computer software and equipment. For each row TICK the CELL that best describes your skills.**

a **Word processor**	I can't do much	I can print a document, change fonts, spell check, insert a footer and page numbers.	I can insert images, create tables, change Page Setup, change margins.	I can use columns and sections, set up styles, and use mail merge.
b **Spreadsheets**	I can't do much	I can enter data, use Sort, create charts [graphs] and modify them.	I can insert some calculations, format cells, insert and delete rows and columns.	I can use complex formulae, use absolute and relative cell references.
c **Databases**	I can't do much	I can create data files, enter data, use simple queries to retrieve data.	I can create simple tables, use wizards to create reports and forms.	I can create a relational database.
d **Slideshow software** **(eg PowerPoint)**	I can't do much	I can create a slideshow, insert images, change font and layout.	I can navigate during a presentation, add animation and transitions, insert hyperlinks.	I can create a master slide, include sound, print handouts, add navigation buttons.
e **Email**	I can't	I can send and access	I can store messages in	I can add a Signature,

424

		do much	emails, and add to and access Address book entries.	folders, locate Sent and Deleted messages, manage the Address book.	and add attachments.
f	**Computer File Management**	I can't do much	I can save files in a folder, create and name folders, navigate between folders, copy, delete and rename files.	I can recognise different file types, navigate between Drives and Directories, access a network, use Help files.	I can zip and unzip files, install software.
g	**The Internet**	I can't do much	I can navigate to known web sites, create Favourites, do basic searches.	I can save images and text, use Advanced search tools, organise Favourites.	I can conduct complex searches, download and install plugins, use different browsers, alter browser preferences.
h	**Web page authoring**	I can't do much	I can create pages and links, insert and format text, insert images.	I can use tables, create external links and email links.	I can create a website with pages and folders, insert sound, upload files to the web.
I	**Digital photography**	I can't do much	I can take photos or video, transfer to a computer.	I can review images/video on camera, adjust camera settings such as flash and close-up.	I can adjust camera menu options such as resolution.
j	**Image editing**	I can't do much	I can do simple editing such as crop, delete and draw.	I can change image size, format and resolution.	I can undertake complex image manipulation using filters and other special effects.
k	**Video editing**	I can't do much	I can do simple editing such as crop, delete and insert.	I can use basic software to introduce transitions, import and edit sound track, add titles and subtitles.	I can use advanced software to apply complex editing and special effects.

Appendix U- Engineering studies student survey results

Questionnaire	N	Min	Max	Mean	SD
Q1a	84	1	4	2.44	1.0
Q1b	84	1	4	2.70	0.8
Q2a	84	1	4	1.85	0.6
Q2b	84	1	4	2.01	0.7
Q2c	84	1	4	1.81	0.8
Q2d	84	1	3	1.87	0.7
Q2e	83	1	4	1.90	0.7
Q2f	83	1	4	1.64	0.7
Q2g	84	1	4	1.65	0.8
Q2h	83	1	4	1.95	0.7
Q2i	84	1	4	1.81	0.7
Q2j	82	1	4	1.88	0.7
Q2k	83	1	4	1.83	0.9
Q5_com	83	0	1	0.78	0.4
Q5_dig	84	0	1	0.74	0.4
Q5_vid	84	0	1	0.50	0.5
Q5_mp3	84	0	1	0.93	0.3
Q5_lap	84	0	1	0.82	0.4
Q5_gam	84	0	1	0.85	0.4
Q5_mob	84	0	1	0.88	0.3
Q5_web	84	0	1	0.49	0.5
Q6	84	1	3	2.94	0.3
Q7	83	1	4	1.25	0.6
Q8mon	84	0	300	53	60
Q8tue	84	0	240	48	46
Q8wed	84	0	270	63	65
Q8thu	84	0	240	62	58
Q8fri	84	0	300	63	64
Q9	78	1	2	1.36	0.5
Q10a	83	1	3	2.25	0.8

Q10b	84	1	3	2.17	0.9
Q10c	84	1	3	1.07	0.3
Q10d	84	1	3	1.49	0.7
Q10e	84	1	3	1.58	0.8
Q10f	84	1	3	1.18	0.5
Q11a	83	1	4	2.61	0.6
Q11b	84	1	3	1.35	0.6
q11c	84	1	3	1.26	0.5
Q11d	83	1	3	1.61	0.6
Q11e	84	1	3	1.25	0.5
Q12a	84	1	3	1.11	0.4
Q12b	84	1	3	1.17	0.4
Q12c	84	1	3	1.20	0.5
Q12d	84	1	3	1.12	0.4
Q12e	84	1	3	1.62	0.7
Q12f	84	1	3	2.79	0.6
Q13a_wp	83	2	4	3.60	0.5
Q13b_ss	83	1	4	3.10	0.7
Q13c_db	83	1	4	2.47	1.0
Q13d_sl	83	2	4	3.60	0.6
Q13e_em	83	2	4	3.66	0.5
Q13f_fm	83	2	4	3.55	0.7
Q13g_in	83	2	4	3.72	0.5
Q13h_wa	83	1	4	2.64	1.1
Q13i_dp	83	1	4	3.52	0.7
Q13j_ie	83	1	4	3.34	0.8
Q13k_dv	83	1	4	2.81	1.0

Appendix V - AIT student survey questionnaire

AIT student survey

Digital Assessment Project

Please circle ONE response for each row.

Gender (circle): **Male** / **Female**

Doing exams in the computer laboratory

| E1. | (a) | How often have you done an exam or test on a computer before? | **Lots** | **Some** | **Little** | **None** |
| | (b) | How much more time would you need to get used to it? | **Lots** | **Some** | **Little** | **None** |

Doing the Applied Information Technology exam

E2.	(a)	It was easy to use the computer for doing the exam.	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
	(b)	It was easy to use the computer in the exam to develop my design ideas.	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
	(c)	The computer was a quick way for presenting my design ideas in the exam.	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
	(d)	The computer was good to create my graphic, graphs and display or poster in the exam.	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
	(e)	The computer was good for reflecting on my design ideas in the exam.	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
	(f)	The computer was good for answering the questions in the exam.	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
	(g)	It was easy to follow the steps of the exam on the computer.	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
	(h)	The steps of the exam helped me	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**

to develop my design ideas.

(i)	Overall, the computer is a good tool for designing products in an exam.	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
(j)	Overall, I was able to show what I can do in the exam.	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
(k)	Overall, it was better doing the exam using a computer than on paper.	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**

E3.   The two best things about doing the Applied Information Technology exam in the computer laboratory:

👍

👍

E4.   The two worst things about doing the Applied Information Technology exam in the computer laboratory:

👎

👎

Experience and Knowledge with Computer Technology

5.   What do you have at **home** (circle ANY of the following that apply to you)

Computer   Digital Camera   Video Camera   MP3 Player (e.g. iPod)

Laptop   Game Console   Mobile Phone   Webcam

6.   Do you have Internet access at **home** (circle ONE)

NO Internet   Dial-up Internet   Broadband Internet

Circle the response that best describes how often you use a computer at home.

Most Days   More than once a week   Most Weeks   Rarely

8.   Estimate the amount of time in MINUTES you spent using computers at school on each day LAST WEEK.

Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**

9.   When you type do you try to touch type (use all of your fingers)?   **YES** or **NO**

10.   Do you, or would you, use a computer to do the following tasks? (circle ONE for each)

(a)   Keep a list of telephone numbers and addresses of friends.   **I do   I would   No**

(b)   Draw a diagram or picture.   **I do   I would   No**

(c)   Type an assignment for school.   **I do   I would   No**

(d)   Do a line graph or pie-diagram as part of an assignment. **I do   I would   No**

(e)   Send a letter to every club member or friend.   **I do   I would   No**

(f)   Communicate using sites like MySpace, Facebook, Youtube   **I do   I would   No**

11.   Circle YES or SOMETIMES or NO to show whether you agree with each of the following statements.

(a)   Using computers makes the work **at school** more difficult. . . . .
    YES or **SOMETIMES** or **NO**

(b)   I enjoy using computers **at school**. . . . .
    YES or **SOMETIMES** or **NO**

(c)   I like to use a computer **at home** to do school work. . . . .
    YES or **SOMETIMES** or **NO**

(d)   I like to find things out for myself instead of being told by the teacher. …
    YES or **SOMETIMES** or **NO**

(e)   Computers are good for the world. . . . .
    YES or **SOMETIMES** or **NO**

12.   Circle either "YES", "Not Sure" or "NO".

(a)   I feel confident working with computers . . …………………………….

YES   Not Sure   NO

(b)   I'm good at using computers. . . . . . . …..……. . . . .**YES**

Not Sure   NO

(c)   I feel OK about trying a new problem on the computer. . . . .

YES   Not Sure   NO

(d)   I usually do well with computers. . . . . . …..…... ……. . .…. . . . .

YES   Not Sure   NO

(e)   I could learn to program a computer. . . . . …….... .. . .**YES**

Not Sure   NO

(f)   Using a computer is very hard for me. . . . . ……...**YES**

Not Sure   NO

13.   Rate yourself on your skill level in using each of these types of computer software and equipment. For each row TICK the CELL that best describes your skills.

a	**Word processor**	I can't do much	I can print a document, change fonts, spell check, insert a footer and page numbers.	I can insert images, create tables, change Page Setup, change margins.	I can use columns and sections, set up styles, and use mail merge.
b	**Spreadsheets**	I can't do much	I can enter data, use Sort, create charts [graphs] and modify them.	I can insert some calculations, format cells, insert and delete rows and columns.	I can use complex formulae, use absolute and relative cell references.
c	**Databases**	I can't do much	I can create data files, enter data, use simple queries to retrieve data.	I can create simple tables, use wizards to create reports and forms.	I can create a relational database.
d	**Slideshow software** **(eg PowerPoint)**	I can't do much	I can create a slideshow, insert images, change font and layout.	I can navigate during a presentation, add animation and transitions, insert hyperlinks.	I can create a master slide, include sound, print handouts, add navigation buttons.
e	**Email**	I can't do much	I can send and access emails, and add to and access Address book entries.	I can store messages in folders, locate Sent and Deleted messages, manage the Address book.	I can add a Signature, and add attachments.
f	**Computer File Management**	I can't do much	I can save files in a folder, create and name folders, navigate between folders, copy, delete and rename files.	I can recognise different file types, navigate between Drives and Directories, access a network, use Help files.	I can zip and unzip files, install software.
g	**The Internet**	I can't do	I can navigate to known web sites, create	I can save images and text, use Advanced	I can conduct complex searches, download and

431

		much	Favourites, do basic searches.	search tools, organise Favourites.	install plugins, use different browsers, alter browser preferences.
h	**Web page authoring**	I can't do much	I can create pages and links, insert and format text, insert images.	I can use tables, create external links and email links.	I can create a website with pages and folders, insert sound, upload files to the web.
I	**Digital photography**	I can't do much	I can take photos or video, transfer to a computer.	I can review images/video on camera, adjust camera settings such as flash and close-up.	I can adjust camera menu options such as resolution.
j	**Image editing**	I can't do much	I can do simple editing such as crop, delete and draw.	I can change image size, format and resolution.	I can undertake complex image manipulation using filters and other special effects.
k	**Video editing**	I can't do much	I can do simple editing such as crop, delete and insert.	I can use basic software to introduce transitions, import and edit sound track, add titles and subtitles.	I can use advanced software to apply complex editing and special effects.

Appendix W – AIT student survey results

AIT Descriptive Statistics

Questionnaire	N	Min	Max	Mean	SD
Q1a	92	1	4	3.22	0.8
Q1b	92	1	4	2.58	0.8
Q2a	94	1	4	2.01	0.6
Q2b	94	1	4	2.16	0.7
Q2c	94	1	4	1.94	0.7
Q2d	93	1	4	1.70	0.7
Q2e	94	1	4	1.98	0.7
Q2f	94	1	4	2.02	0.6
Q2g	94	1	4	2.04	0.7
Q2h	94	1	4	2.07	0.7
Q2i	94	1	4	1.78	0.7
Q2j	94	1	4	2.11	0.7
Q2k	91	1	4	1.88	0.8
p1a	94	0	4	2.47	1.2
p1b	94	0	4	2.29	1.1
p2a	94	0	4	1.87	0.7
p2b	94	0	4	1.89	0.7
p2c	94	0	3	1.77	0.7
p2d	94	0	4	1.73	0.8
p2e	94	0	4	1.90	1.0
p2f	94	0	4	1.74	1.0
p2g	94	0	4	1.86	1.0
p2h	94	0	4	1.95	1.0
p2i	94	0	4	1.71	1.0
p2j	94	0	4	1.78	1.0
p2k	94	0	3	1.70	1.0
Q5_com	94	0	1	0.71	1.0
Q5_dig	94	0	1	0.65	0.5
Q5_vid	94	0	1	0.39	0.5
Q5_mp3	94	0	1	0.77	0.4

Q5_lap	94	0	1	0.66	0.5
Q5_gam	94	0	1	0.64	0.5
Q5_mob	94	0	3	0.83	0.5
Q5_wbc	94	0	1	0.48	0.5
Q6	85	1	120	4.26	12.8
Q7	82	1	120	2.72	13.1
Q8mon	94	0	360	75	71
Q8tue	94	0	360	77	73
Q8wed	94	0	360	82	75
Q8thu	94	0	360	76	74
Q8fri	94	0	420	87	81
Q9	75	1	3	1.25	0.5
Q10a	85	1	3	2.20	0.8
Q10b	83	1	3	1.90	0.9
Q10c	83	1	3	1.11	0.3
Q10d	83	1	3	1.48	0.7
Q10e	83	1	3	1.72	0.7
Q10f	83	1	3	1.19	0.5
Q11a	82	1	3	2.80	0.5
Q11b	82	1	3	1.26	0.5
Q11c	82	1	3	1.37	0.7
Q11d	82	1	3	1.71	0.6
Q11e	82	1	3	1.33	0.5
Q12a	82	1	2	1.09	0.3
Q12b	82	1	3	1.20	0.4
Q12c	82	1	3	1.23	0.5
Q12d	82	1	2	1.09	0.3
Q12e	82	1	3	1.44	0.6
Q12f	82	1	3	2.68	0.7
Q13a_wp	75	1	4	3.56	0.7
Q13b_ss	75	1	4	3.09	0.8
Q13c_db	75	1	4	2.71	1.0
Q13d_sl	75	1	4	3.51	0.7
Q13e_em	75	1	4	3.57	0.7

Q13f_fm	75	1	4	3.53	0.8
Q13g_in	75	1	4	3.72	0.6
Q13h_wa	75	1	4	3.08	1.0
Q13i_dp	75	1	4	3.39	0.8
Q13j_ie	75	1	4	3.51	0.7
Q13k_dv	75	1	4	2.92	1.0